Unites States Department of Agriculture

Natural Resources Conservation Service

Resource Economics and Social Sciences Division

Historical Notes
Number 5

Historical Changes in Soil Erosion, 1930-1992

The Northern Mississippi Valley Loess Hills

M. Scott Argabright, Roger G. Cronshey, J. Douglas Helms, George A. Pavelis, H. Raymond Sinclair, Jr.

Cover photograph: Coon Creek watershed, Vernon County, Wisconsin. Tim McCabe. 1994.

HISTORICAL CHANGES IN SOIL EROSION, 1930-1992
The Northern Mississippi Valley Loess Hills

M. Scott Argabright
Agronomist
NRCS-USDA, Lincoln, Nebraska

Roger G. Cronshey
Hydraulic Engineer
NRCS-USDA, Washington, D.C.

J. Douglas Helms
Senior Historian
NRCS-USDA, Washington, D.C.

George A. Pavelis
Economist
ERS-USDA, Washington, D.C.

H. Raymond Sinclair, Jr.
Soil Scientist
NRCS-USDA, Lincoln, Nebraska

Natural Resources Conservation Service
Economic Research Service
United States Department of Agriculture
Washington, D.C.
September 1996

Foreword

This is a study of soil erosion conditions in the 1930's as opposed to 'now' (1992) in a major land resource area of the humid region, the Northern Mississippi Valley Loess Hills (MLRA 105), or what is sometimes called the "Driftless Area of the Northern Mississippi Valley ". The study describes and quantifies, using modern methods, the kinds of erosion problems identified in the nationwide Reconnaissance Erosion Survey, which led to the creation of what is now the Natural Resources Conservation Service (NRCS). The Survey and Service are the legacies of Hugh Hammond Bennett and other pioneers in the conservation of soil and other natural resources.

The project was a contributing component of the Third USDA Appraisal of Conditions and Trends on Soil, Water and Related Natural Resources in the United States. Such periodic assessments were mandated in the Soil and Water Resources Conservation Act of 1977. As part of this effort we undertook an historical assessment of the effect of conservation programs in an important livestock and crop production area of the Midwest. The Universal Soil Loss Equation (USLE) was applied to evaluate the magnitude of soil losses in 1982 and 1992 compared to 1930. The same methodology would be feasible for some other areas where soil erosion losses are primarily water-related.

For purposes of historical comparison it was desirable that the area be one where cropland agriculture, then and now, used a large part of the landscape. We preferred an area with a relatively rough topography, where water erosion posed a threat on slopes, as opposed to an area of slight relief. Also, because the analysis attempted to assess the probable effectiveness of private and public conservation activities, the area of study preferably would be one where there had been some early conservation initiatives by public agencies. A logical choice was an important agricultural region that included some research and demonstration projects. Also, the Driftless area has been studied by a number of geomorphologists whose works are discussed in Beach (1994). We hope this study adds to the discussion of the relationship of erosion, soil loss, and what Beach terms the 'sediment delivery problem'.

In 1933 a new Federal agency, the Soil Erosion Service, selected Coon Creek in Wisconsin as the first watershed within which to demonstrate the values of soil conservation measures. In 1935 this agency became the Soil Conservation Service, now the Natural Resources Conservation Service (NRCS). The Service began working in the Driftless area in 1933 when it located its first demonstration project at Coon Valley, Wisconsin, a 49,400-acre watershed including parts of La Crosse, Monroe and Vernon Counties. The SCS staff worked with local farmers to plan conservation measures for their farmland such as strip cropping, contouring, fencing woodland, and controlling

gullies and stream bank erosion. At about the same time the U.S. Department of Agriculture (USDA) had established a number of Conservation Experiment Stations across the country, one of which was located at nearby La Crosse, Wisconsin.[1]

Determining how effective individual conservation efforts and public programs for research, technical assistance and cost sharing have been in reducing soil erosion in a broad region like MLRA 105 was a main object of this interdisciplinary study. A second object was to illustrate a methodology whereby long-term changes in erosion conditions as determined for this region might also be applied in other regions.

The present study was greatly facilitated by the help of others in planning the work and helping access the large body of required documents and data, much of which is archival and not in the published literature. In the Department of Agriculture Lane Price and Jeffrey Goebel of the Resources Inventory Division of NRCS helped outline a general strategy for applying the USLE to 1930 conditions and using USLE data from the 1992 National Resources Inventory to approximate current conditions. NRCS Field Office Technical Guides and other interpretive data for Wisconsin, Iowa, Minnesota and Illinois were available or provided through Lee Herndon of the National Headquarters Staff of the NRCS by David Breitbach in Minnesota, John Pingry in Wisconsin, and Robert Dayton and Dennis Miller in Iowa. Mr. Miller of the NRCS State Office in Iowa and Owen Lee of the National Headquarters Staff of NRCS assisted in explaining small watershed program activities. Maps showing these projects and the status of county soil surveys in the region were prepared by Stacey Wood in NRCS The high quality and comprehensiveness of USDA's Soil and Erosion Surveys, both historic and current, were instrumental in making this study feasible.

Especially useful were onsite interviews in Elkader, Iowa in February 1995 with David Gibney, Unit Conservationist for Clayton County and Mark Bowman, farmer and Chair of the local Soil and Water Conservation District Committee. Mr. Bowman willingly shared his own experiences and recollections concerning the crop rotations and farming practices followed in the

---

[1] Details on these early conservation efforts in the region are in a 1939 unpublished document: *Project Monograph, Coon Valley and Coon Creek Project Report (Region 5, Wisc. 1).* U.S. Dept. Agr., Soil Conservation Service. 107 pp. Also see Helms, J.Douglas. 1982. "Coon Valley, Wisconsin: A Conservation Success Story" In *Readings in the History of the Soil Conservation Service.* U.S. Dept. Agr., Soil Conservation Service, Historical Notes. No.1. pp51-53. A detailed review of the evolution of conservation programs in Wisconsin is in Leonard C. Johnson's *Soil Conservation in Wisconsin: Birth to Rebirth* (Madison: University of Wisconsin, 1991). 332pp.

Northern Mississippi Valley in the 1930s and 1940s. Also, in August 1995 Rocky Taign of the Elkader Field Office of the Natural Resources Conservation Service assisted in locating sites where repeat photographs of land uses and conservation practices could be obtained.

Out of print and current State crop reports covering all counties in the study area were obtained through William Dowdy of the Crops Branch in the National Agricultural Statistics Service, with additional help from Garry Kepley, George Howse, Bernie Jansen and other personnel in Illinois, Minnesota and Iowa. Advance county sheets from the 1992 Census of Agriculture and assistance in interpreting land use items in the older Censuses were provided by Robert Smith and Debra Norton of the Census Bureau's Agriculture Division. William Lindamood, Edward Reinsel, Robert Reinsel, Dan Deprey and Sean Riley of the Economic Research Service were especially helpful in accessing and/or compiling the Census information. Others in ERS offering suggestions and assistance include Audrae Erickson, Dwight Gadsby, Ralph Heimlich, Catherine Kascak, Tim Osborn and Carmen Sandretto. In addition to contributing many hours in word processing assistance, Janice Pavelis greatly improved the layout of the numerous tables and charts supporting our analysis and conclusions.

A number of editorial improvements were suggested by Rebekah Davis, a 1995 and 1996 summer intern with the Natural Resources Conservation Service. She and another intern, Wykesha Tripp, and also Claudette Hayes of the NRCS publications group, also assisted in the printing arrangements.

Executive Summary

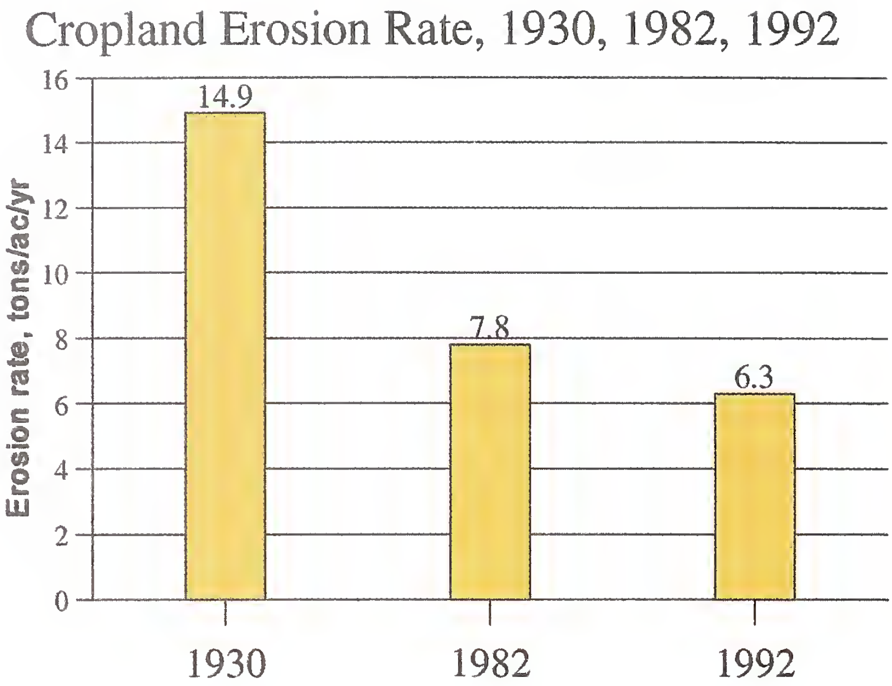
Changes in soil erosion conditions between 1930 and 1992 have been evaluated for the Northern Mississippi Valley Loess Hills, sometimes called the "Driftless Area" of the Northern Mississippi Valley. As naturally defined, this area includes 18,860 square miles (12.1 million acres) covering the major part of 28 counties--six counties in northeast Iowa, six counties in southeastern Minnesota, 15 counties in southwestern Wisconsin and a single county (Jo Daviess) in the northwest corner of Illinois (figure 1).

Five of the 28 counties were chosen as a sample for which land uses, farm management practices, farming methods, and crop and livestock enterprises during the years 1925-1935 were researched from early USDA Soil Surveys, State Experiment Station Research Bulletins, and Agricultural Census reports. This information was used to 'reconstruct' rates of soil loss for the base year 1930 on land used for row crops, oats and other small grains, and rotation meadow. The sample counties were: Clayton County, Iowa; Houston and Winona Counties, Minnesota; and Crawford and Vernon Counties, Wisconsin.

The Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith of USDA's Agricultural Research Service was used to calculate erosion rates per acre of land in these crops. The formula integrates the influences on erosion of rainfall, soil erodibility, field slope and slope length, cropping sequences, crop yields, tillage practices, and any supporting conservation measures. The erosion rates for 1930 calculated for the sample counties were compared with erosion rates for 1982 and 1982. The 1982 and 1992 rates, also based on the USLE, were made available from the National Resources Inventories of the Natural Resources Conservation Service.

Chart A shows the average annual cropland erosion rates for the region expected under the land use and management conditions prevailing in 1930, 1982 and 1992. The average annual rate of soil loss in 1930 on the land in row crops, small grains and rotation meadow is estimated to have been 14.9 tons per acre per year, plus or minus an allowance for error of 1.0 ton per acre (6.7%). There is a 95-percent level of confidence that the actual rate in 1930 was somewhere between 13.9 and 15.9 tons/ac/yr. By 1982 the average rate of soil loss on land in these three crop groups in the region had been reduced to 7.8 tons per acre per year, representing a 48-percent decrease from the 1930 rate. The allowance for sampling error in this estimate is about 0.4 ton per acre (5.1%). By 1992 the average rate of soil loss on land in these three crop groups in the region had been reduced to 6.3 tons per acre per year--a 58-percent decrease from the 1930 rate. The error in this case is about 0.3 ton per acre (4.8%).

Chart A

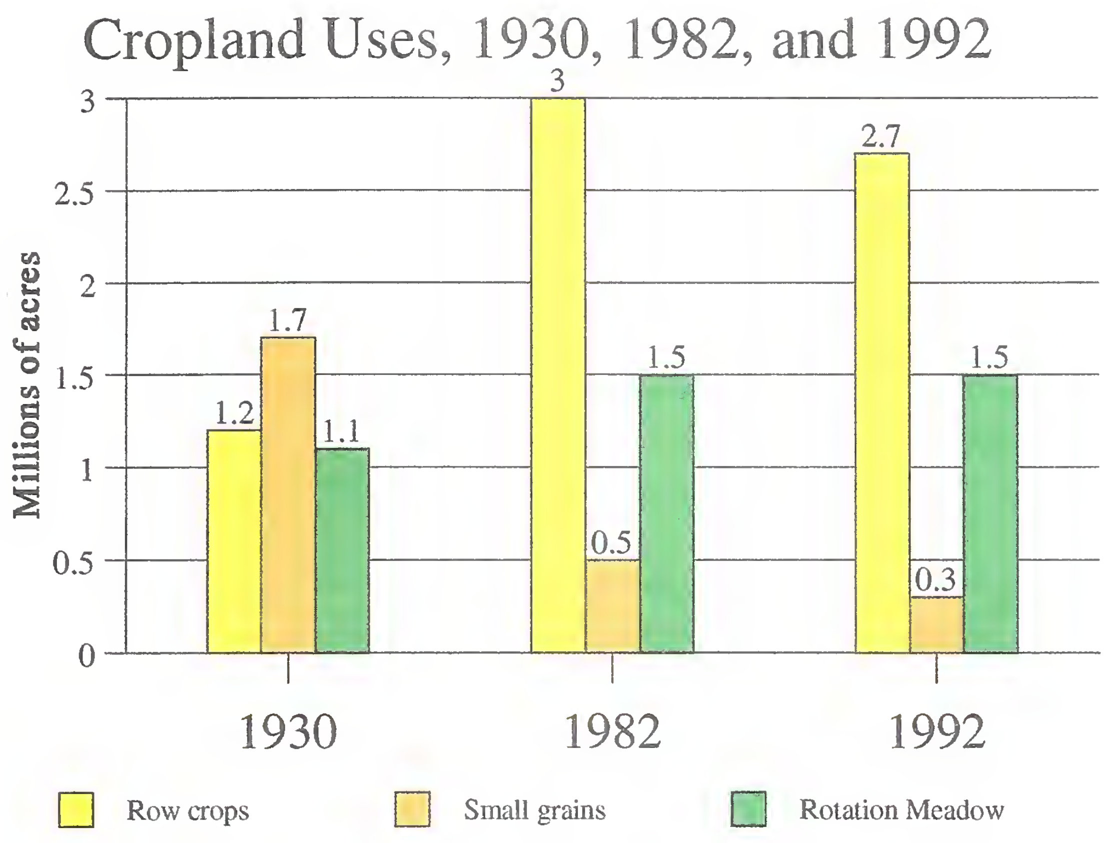


When multiplied by the acres in principal crops the reduced gross erosion rates per acre from 1930-1992 translate into a reduction of between 42 and 58 percent in the total or 'gross' amount of erosion occurring on the land in row crops, small grains, and meadow. In 1930 between 54 and 64 million tons of soil per year were being displaced from cropland. By 1992 these losses had been reduced to between 27 and 31 million tons per year. About 64 percent of the reduction in total erosion between 1930 and 1992 was achieved by 1982, and 36 percent since 1982.

'Excess' rates of erosion were also estimated. The excess rate of erosion was defined as the gross rate of soil displacement per acre less the tolerance rate '**T**' that can occur without an appreciable loss in soil productivity, and without applying additional nutrients. In 1930 about 87 percent of all land in principal crops was eroding in excess of **T**. By 1992 this proportion had been reduced to about 39 percent.

Summing up the overall results of this study: Under conditions in 1992 the average annual erosion rate per acre of the land in principal crops in the Northern Mississippi Valley Loess Hills (MLRA 105) was only 42 percent of the rate we estimated for 1930, and the total amount of soil being displaced on cropland in 1992 was only 49 percent of the amount displaced in 1930. These reductions were achieved despite the area used for row crops, small grains or rotation meadow in 1992 being 16 percent greater than in 1930. The area in row crops alone in 1992 was 2.3 times the

Chart B



area in row crops in 1930-- 2.7 million acres in 1992 as compared to 1.2 million acres in 1930.

Chart B compares the use of cropland for row crops, small grains and rotation meadow in 1930, 1982 and 1992. Note that the combined area in row crops or small grains in 1992 (3.0 million acres) was less than the area in 1982 (3.5 million acres), by about 500 thousand acres. The 678 thousand acres in the Conservation Reserve Program in 1992 doubtless included significant acreages cropped in 1982, but also some cropland that was not being farmed in 1982.

It appears that the reductions in erosion in this region since the 1930's were not accomplished by using land resources less intensively, such as leaving land in small grains or permanent hay meadow instead of growing more row crops. They were largely the result of investing in terraces or other improvements, practicing stripcropping, and reducing tillage.

Data from the Conservation Technology Information Center (CTIC) indicate that, as of 1994, no-till farming had been adopted on about 440,000 acres (12 percent) of the land planted to row crops or small grains, compared to none in 1930 and only 3 percent in 1984. In 1994 mulch or ridge tillage was practiced on just over a million acres (26 percent) of the acres in planted crops. Including all variations, some form of conservation tillage was practiced in the region on nearly 40 percent of the area planted to row crops or small grains in 1994.

According to the 1992 Census of Agriculture, about 66,000 acres of the croppable land (less than 1 percent) in the region were in various set-aside or similar short-term diversion programs of USDA. These programs are apart from the Conservation Reserve Program (CRP) aimed at retiring highly erodible cropland from production through long-term (10-year) contracts with landowners. A cumulative total of nearly 726 thousand acres in the region were in the Conservation Reserve in 1994. The CRP enrollments accounted for roughly 18 percent of the highly erodible cropland and for 85 percent of all cropland not harvested in the region.

Some limitations of and important conclusions from this study are:

1. The conservation practices initiated since the 1930's enhance many other resources and values such wildlife, water quality, and aesthetic and recreational qualities. We did not attempt to quantify these contributions. Nor did we try to determine the relative contributions of Federal or State agencies and individuals in greatly reducing erosion in the region studied, essentially because public conservation and programs involve cooperation between landowners and public agencies.

2. The various reasons why farmers may or may not give soil conservation a high priority in their management plans were not investigated here. The need for current income is an important factor in how farmers will integrate conservation in their management plans. The current preference for corn and other row crops in the study area can be attributed to their importance as cash crops, especially to support the growing hog industry. It would appear that every effort should be made to continue and improve on conservation measures protecting the cropland used so intensively.

3. Farmers of an earlier day in the region were conservation minded. Few attempted to grow corn continuously and steep slopes were generally left in hay or pasture, although pastures were often overgrazed and otherwise poorly managed. Preserving cropland fertility with barnyard manure and selecting crops to fit a primarily livestock-oriented farm economy were primary concerns. The adverse consequences of farming up and down slopes rather than on the contour, and usually removing and sometimes burning crop residues, were not well understood.

4. Farmers of today are also conservation minded but their situations and tactics differ. The apparent tendency is to plant row crops wherever feasible, but to install the necessary land improvements like terraces, farm slopes on the contour and minimize tillage operations.

5. Soil erosion has been greatly reduced since 1930 in the Driftless Area of the Northern Mississippi Valley, but the results of our study do not necessarily apply elsewhere. Agriculture is too dynamic and diverse to warrant such generalizations. However, this study does offer a clear corrective to the sweeping generalizations which claim that soil erosion has remained static or worsened since the midst of the Great Depression and the dust bowl days of sixty years ago.

6. This study represents an original effort to quantify soil erosion losses 60-plus years ago across a broad region. The numerical results, while reliable, should not be regarded as exact. Climatic conditions and basic soil characteristics may not have changed much, but it is virtually impossible and in any case would be prohibitively expensive to determine exactly how each farm field was managed in the 1930s. The results we give reflect our best judgement as to which source data, assumptions, and analytical methods to apply to the problem. In this sense our findings can be regarded as accurate representations of farming and erosion conditions in the 1930s and the present time. Further, the continued conversions to no-till farming and other variations of conservation tillage suggest that the expected average annual erosion rate on cropland as of 1995 is measurably less than the 6.3 tons/ac/yr we estimated for the year 1992.

Contents

Page

Foreword...iii

Executive Summary...vii

Background...1

Objectives and Plan of Report...3
- Initial Considerations...3
- Study Area MLRA 105...6
- Cropland the Major Source of Erosion...6
- Selection of Sample Counties...9

Land Use and Production Profiles, 1930 and 1992...11
- Importance of Pasture and Woodland Use for Livestock...12
- Crops and General Economic Profiles...14

Early Farming Systems Related to Soil Erosion...17
- Crop Selection and Crop Rotations...18
- Soil Management Problems...20
- Tillage and Crop Residue Practices...20
- Conservation Efforts...21

Estimating Cropland Soil Erosion...22
- Some Prior Applications...23
- Anticipating the Universal Soil Loss Equation...25

Applying the USLE to 1930 Conditions...25
- Possible Crop Sequences...27
- Crop YieldLevels...27
- Tillage Systems...28
- Crop Residues...28
- Crop Stage Dates...29

Cropland and Crop Classifications...30
- Cropland GroupAB...32
- Group A--Minor Row Crops...32
- Group B--Intensive Corn...32
- Group C--Two-crop Small Grain/Meadow Rotations...33
- Group D--Three-crop Corn/Small/Grain/Meadow Rotations...33

Steps in Deriving USLE Erosion Rates for 1930....35

Erosion in Sample Counties, 1930, 1982 and 1992....36
Cropland Erosion Rates....38
Sample County Results....39

Erosion in MLRA 105, 1930, 1982 and 1992....41
Regional Cropland Uses....41
Approximating Regional Erosion in 1930....45
Productivity-Decreasing Erosion....49

Conservation in MLRA 105....52
Onfarm Conservation Practices....52
Conservation Tillage....55
Conservation Reserve and Diversion Programs....56
Watershed Protection....60

Possible Related Studies....64

References....66

Appendix A. Supplemental Tables....71
Appendix B. MLRA 105, the Northern Mississippi Valley Loess Hills....85
Appendix C. Sample CountyAgricultural Histories....86
Appendix D. Other Major Land Resource Areas for Study....90

Tables*

Table 1. Severity of erosion in Clayton County, Iowa and Winona County, Minnesota, ca. 1934 7

Table 2. Livestock inventories and sales in 1930 and 1992 for five sample counties versus all 28 counties in MLRA 105 15

Table 3. General economic and crop production profiles for 1930 and 1992 for five sample counties versus all 28 counties in MLRA 105 16

Table 4. Cropland and crop groups by land use capability classes in five sample counties in MLRA 105, 1930 31

Table 5. Soil loss rates by crop groups and land use capability subclasses for five sample counties in MLRA 105, 1930 42

Table 6. Principal cropland uses and soil erosion in 1930 and 1992 in five sample counties in MLRA 105 43

Table 7. Cropland erosion in 1930 and 1992 for five sample counties in MLRA 105 44

Table 8. Cropland erosion in 1930 and 1992 in 28 counties predominantly in the Northern Mississippi Valley Loess Hills (MLRA 105) 53

Table 9. Soil loss rates in excess of 'T' by crop groups and land use capability subclasses five sample counties, 1930 57

Table 10. Erosion > 'T' in 1930, 1982 and 1992 in 28 counties predominantly in the Northern Mississippi Valley Loess Hills 59

Table 11. Erosion control and other conservation practices in 1982, 1987, and 1992, MLRA 105 61

* Supplemental tables are in Appendix A.

HISTORICAL CHANGES IN SOIL EROSION, 1930-1992
The Northern Mississippi Valley Loess Hills, MLRA 105

Background

This study determines changes in soil erosion conditions between 1930 and 1992 in a selected Major Land Resource Area of the United States, the Northern Mississippi Valley Loess Hills (MLRA 105), sometimes called the "Driftless Area of the Northern Mississippi Valley". It is an area of 18,860 square miles (48,847 square kilometers), including all or the major part of 15 counties in southwestern Wisconsin, six counties in southeastern Minnesota, six counties in northeast Iowa, and a single county (Jo Daviess) in the northwest corner of Illinois (figure 1).

The main comparison is between 'present' (1992) conditions and the severe conditions that were documented in the early thirties in the Reconnaissance Erosion Survey (RES) and other field studies of the time led by Hugh Hammond Bennett and others. The National Reconnaissance Erosion Survey led in large part to the soil and water conservation research and project programs in place today (U.S. National Resources Planning Board, 1936).[2]

At a 1984 Symposium on the History of Soil and Water Conservation, Trimble observed: "Both the popular and scientific press dramatize the soil erosion problem as a 'crisis', often implying that it is worse than in the 1930's."(Trimble,1985,p.77). He and Lund express the same thoughts in their analysis of conservation progress since the 1930's in the Coon Creek Basin of Wisconsin (Trimble and Lund,1982,p.1).

Conservation programs of the U.S. Department of Agriculture have been in place for 60-plus years in the Natural Resources Conservation Service (NRCS, formerly the SCS), the Forest Service (FS), and the presently named Farm Service Agency. Others of a project-level or regional nature have continued for nearly 40 or more years, such as the Watershed Protection and Flood Prevention Program (since 1954), and the Great Plains Program (since 1958). More recent examples include the Conservation Reserve and Wetland Reserve Programs, authorized in 1985 and 1990, respectively. These programs are aimed at protecting highly erodible and/or environmentally sensitive areas through long-term contracts with landowners.

Methods for quantifying erosion and hydrologic processes have become more reliable and widely used. They have made it possible to estimate soil dislodgement, transport and sediment deposition on a more precise and local level, and to more accurately determine their economic

---

[2] Literature citations in this report employ the author-date, or author-date-page convention. A complete list of references begins on page 66.

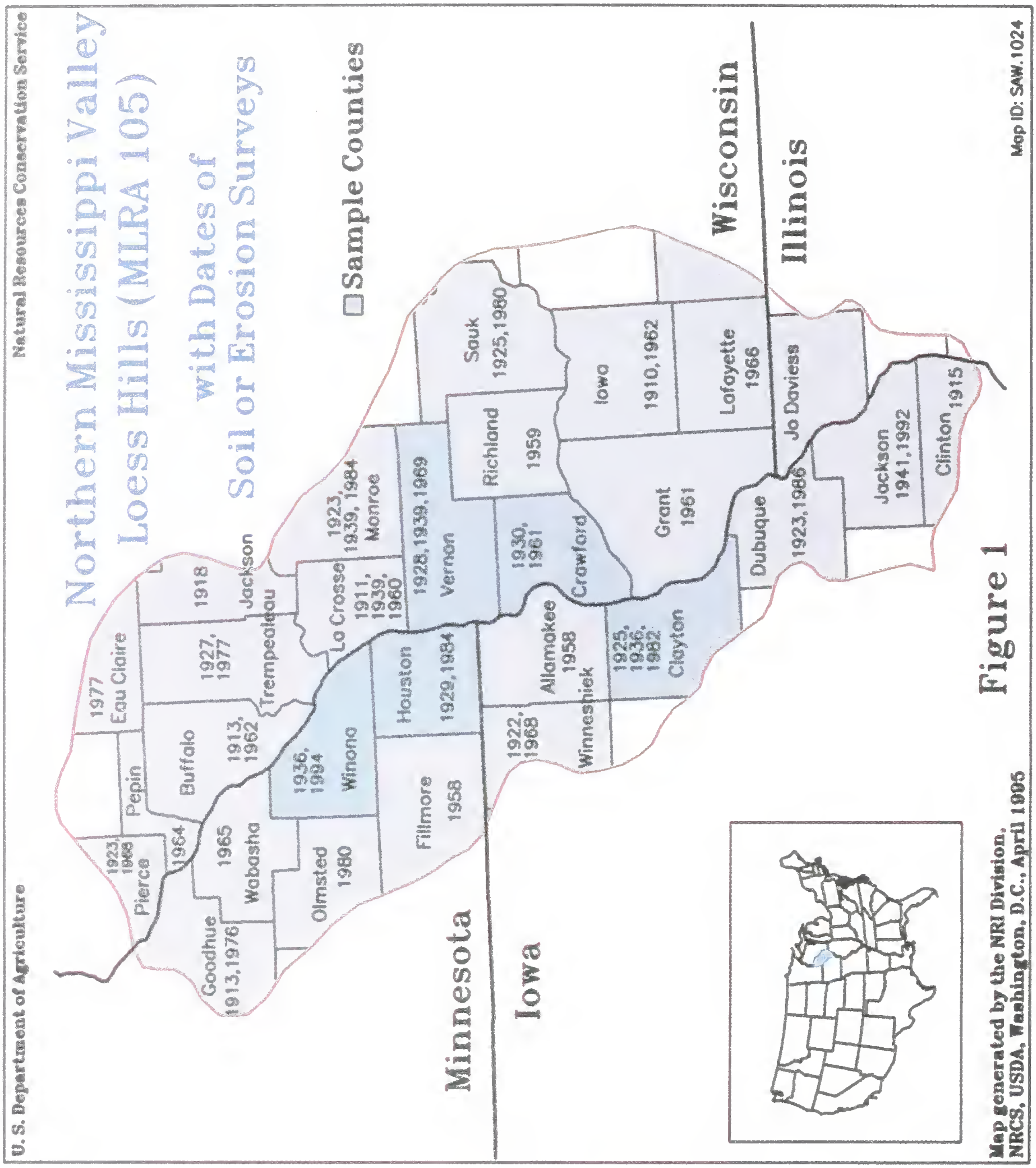

U. S. Department of Agriculture
Natural Resources Conservation Service
Northern Mississippi Valley
Loess Hills (MLRA 105)
with Dates of
Soil or Erosion Surveys
Sample Counties
Minnesota
Iowa
Wisconsin
Illinois
Goodhue
1913,1976
Pierce
1923,
1968
1964
Pepin
Eau Claire
1977
Wabasha
1965
Buffalo
1913,
1962
1927,
1977
Trempealeau
1918
Jackson
Olmsted
1980
Winona
1936,
1984
Fillmore
1958
Houston
1929,1984
La Crosse
1911,
1939,
1960
Monroe
1923,
1939,1984
Vernon
1928,1939,1969
Winneshiek
1922,
1968
Allamakee
1958
Clayton
1925,
1936,
1982
Crawford
1930,
1961
Richland
1959
Sauk
1925,1980
Grant
1961
Iowa
1910,1962
Lafayette
1966
Dubuque
1923,1986
Jo Daviess
Jackson
1941,1992
Clinton
1915
Map generated by the NRI Division,
NRCS, USDA, Washington, D.C., April 1995
Map ID: SAW.1024

Figure 1

significance.[3] This study focuses on soil 'displacement', and is called 'gross erosion', This is not necessarily equivalent to soil 'loss'.

The early applied economic studies dealt mostly with representative farm situations on a with- versus a without conservation level, but not tied to physical measures of soil loss (Ball and Heady,1957). Two conceptual studies for economic analysis are those of Bunce (1942), and Heady and Jensen (1951). They foresaw the need for and likely emergence of interdisciplinary research on evaluation methods and field problems.

As sedimentation and related water quality problems of nonpoint origin have become more obvious and of concern to the public, research studies have tended to encompass wider areas. Soil and water management issues, both onsite and offsite, and of both production and environmental importance, are best treated within overall frameworks that recognize and balance the interests of farmers and others. Degradation of the natural environment through excess soil erosion and various forms of pollution are a very real form of disinvestment in the stock of available resources, for individuals as well as society at large.

Objectives and Plan of Report

The main objective was to compare erosion conditions in MLRA 105 in the base year 1930 with conditions 'now', namely as of the latest year (1992) for which the required information is available. The methodology is described in enough detail to guide similar studies in other regions. The methods may also suggest some alternative approaches for conducting similar studies.

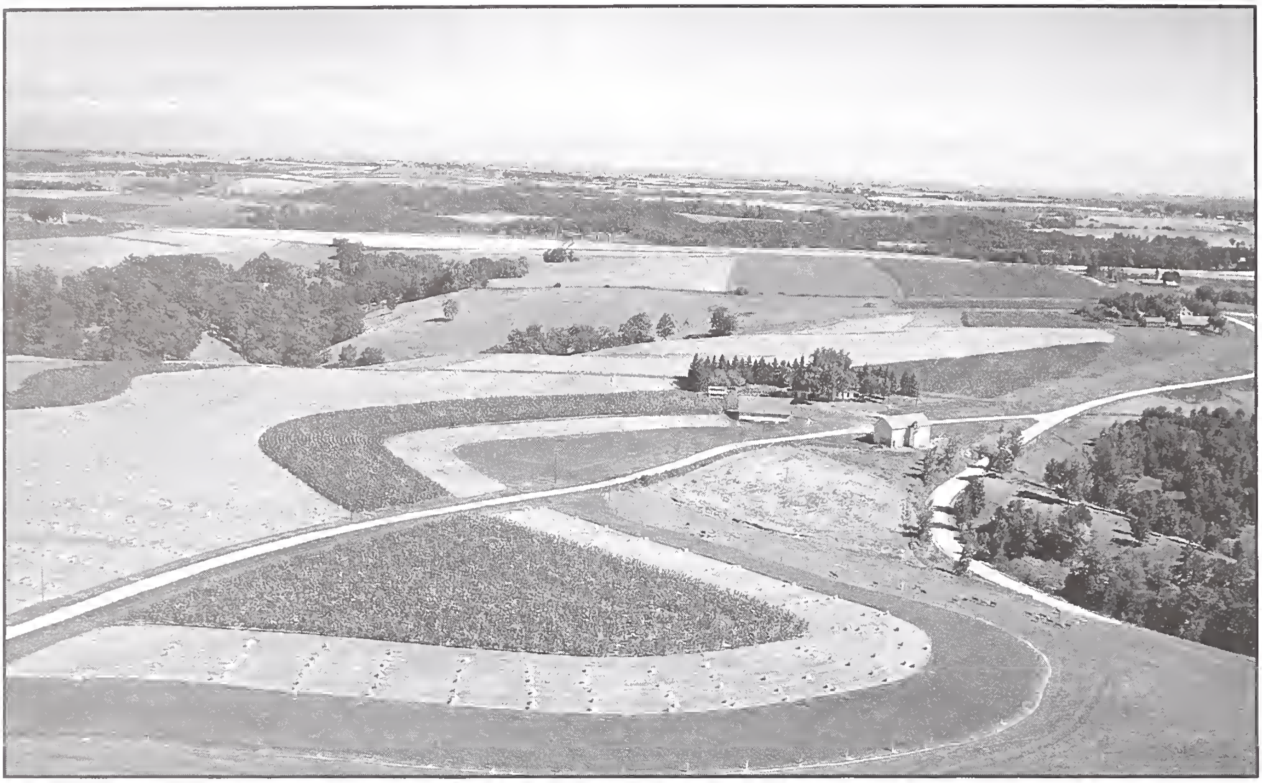
Initial Considerations

Because soil erosion is directly associated with cropping and farm management practices under given climatic and soil characteristics, time intervals examined for area studies are best chosen to coincide with selected Censuses of Agriculture. Final State and county-level data from the Census of Agriculture for 1992 became available in late 1994 and were used in this study. Annual county-level cropping and livestock data maintained in State statistical offices were valuable

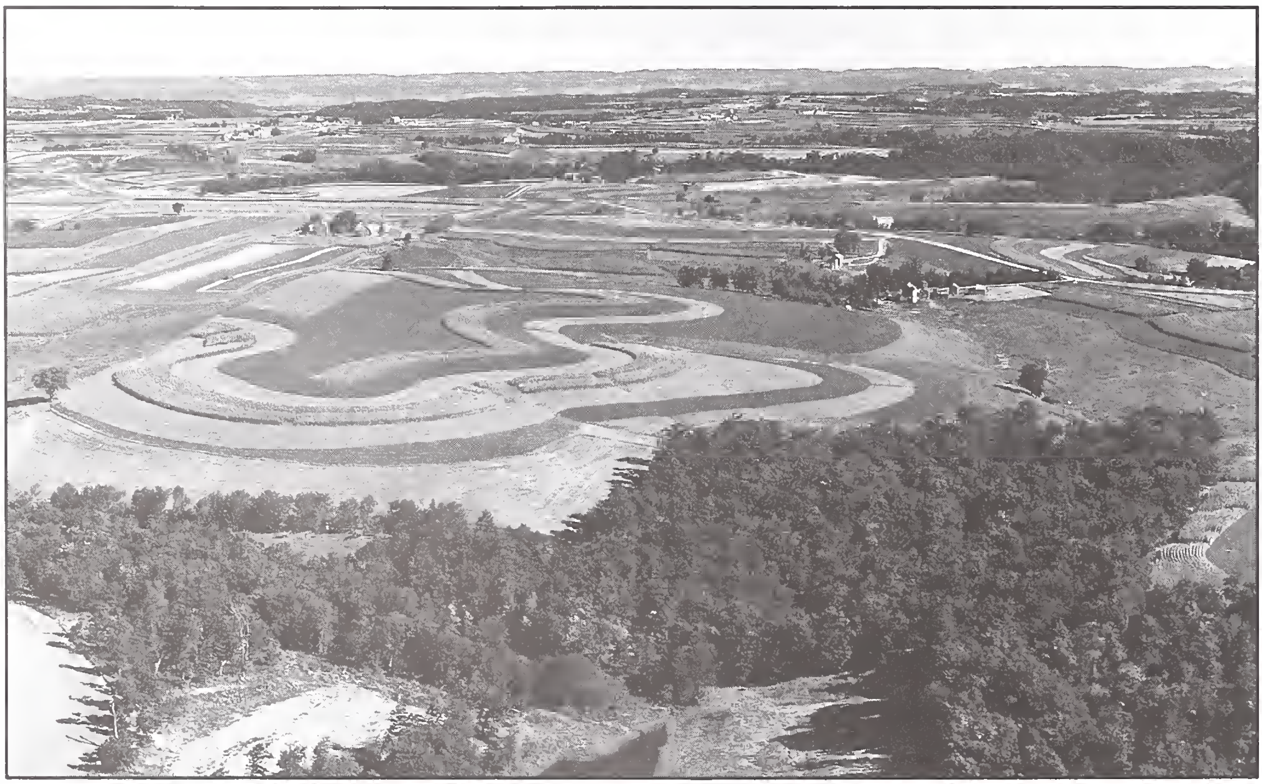
---

[3] The research of Trimble and Lund in the Coon Creek Basin of Wisconsin demonstrates how land use and management practices determine erosion levels in source areas (tributaries to PL566 structures) and can be hydrologically connected to reservoir sedimentation rates, as well as off-site stream channel erosion, valley sedimentation and out-of-basin sediment loads (Trimble and Lund, 1982). The ten subbasins they studied totaled 7,950 acres within Monroe and Vernon counties, Wisconsin, two of the 28 counties included in MLRA 105.

Continued Use of Conservation Practices at Former SCS/USDA Demonstration Projects



Stripcropping in Winona County, Minnesota, 1949. NRCS/USDA photo. (Minnesota-1580).



Stripcropping in the Coon Creek watershed, Wisconsin, 1963. Photo by Erwin W. Cole, NRCS/USDA. (Wisconsin 1418).

for filling gaps in the Census reports, especially in making estimates of average annual crop yields and information on planted as well as harvested acreages. Erosion calculations under field, management and probable rainfall conditions through a complete crop cycle depend on the acres of crops planted as well as harvested.

A thorough time-series evaluation of long-term changes in erosion conditions in a large multi-county area like MLRA 105 would require accessing all 20 agricultural censuses or other surveys conducted since 1880. Eight census years would be the most pertinent: 1930, 1935, 1940, 1954, 1969, 1982, 1987, and 1992. They cover the dates of early erosion surveys, early soil surveys, major turning points in national history, years in which major conservation programs were initiated, and years for which National Resource Inventory data are available.

Interval-by-interval comparisons were not made in this study. Rather, the Agricultural Census reporting year 1930 (crop season 1929) was chosen as the center-point or base year reflecting farming methods generally prevailing during the period 1925-1935, the decade prior to when the Reconnaissance Erosion Survey was conducted in 1934. The study is a cross-sectional or 'snapshot' comparison of erosion conditions, agricultural production, and conservation activity between the base year 1930 and the years 1982 and 1992, the years for which the most recent information is available--on erosion from the 1992 National Resources Inventory and on land use and crop production primarily from the corresponding Censuses of Agriculture, or from State statistical agencies and other sources as needed.

Reconstructing farming and erosion conditions of more than 60 years ago requires an understanding of the manner in which agriculture evolved in MLRA 105, and why certain cropping patterns and practices were followed. A first step was to research the development of agriculture in five sample counties, recognizing that each area has its own unique history. This important background material is in Appendix C. Some current population, income source and other economic data are also given for these counties.

It was also necessary to decide the land uses for which estimates of erosion for 1930 versus 1982 and 1992 could or should be made, given time and cost constraints as well as their technical importance. Reasons are given for restricting the erosion comparisons to cropland and selecting particular sample counties for analysis. The five counties chosen are highlighted in figure 1.

Crop and livestock production data for 1930 and 1992 were then compiled for the sample counties and all 28 counties in MLRA 105, to determine whether the sample was valid and indicate the approximate values of the various factors involved in the Universal Soil Loss Equation (USLE).

Farming systems and practices in the decade 1925-1935, as related to crop decisions, soil management problems, tillage and residue practices and conservation efforts are researched in some detail. This information was essential for determining proper values for the cover-management and conservation practice factors in the USLE. The USLE is then applied retroactively to 1930 in MLRA 105 with reference to climatic and soils information, available cropland, crop groups, crop rotations and sequences, tillage methods and residue management practices.

The estimated erosion rates for 1930 are compared with those estimated for the same five sample counties from USDA's 1982 and 1992 National Resources Inventories (NRI). The NRI rates of soil loss are similarly based on the USLE. They reflect the climatic, soils, field, and cropping characteristics plus other observations for specific sample points, rather than for complete soil map units, land use capability classes or crop groups.

Erosion rates for 1982 and 1992 for the entire 28-county region have also been obtained from the NRI. The 1982 and 1992 erosion rates for the five sample counties and the 28-county region as a whole are examined, as well as those for between 1930 and 1992 just for the five sample counties. These relations are then used to approximate erosion rates on all cultivated cropland and rotation meadow in the Northern Mississippi Valley Loess Hills as of 1930.

Study Area MLRA 105

Major Land Resource Area 105, the Northern Mississippi Valley Loess Hills, has a total land area according to official Census records of about 19,260 sq.miles (49,900 sq.km.), as adjusted to the boundaries of the 28 counties mainly included. Its natural size is slightly less--18,860 sq.miles, of which 103 sq.mi. are held by Federal agencies. Figure 1 shows its natural boundaries and identifies the 28 counties predominantly included. The region is comparable in size to the combined areas of New Hampshire and Vermont. A more complete description of the area is in Appendix B.

Cropland the Major Source of Erosion

This study was confined to the analysis of water-related (sheet and rill) erosion on cropland. Apart from cost, the reason for focusing on cropland is that the bulk (around 85 percent) of the erosion reported for an area covered in an early SCS Physical Land Survey (No. 28) for Clayton County, Iowa, was said to occur on cropland. Most of the severe sheet and gully erosion (95-100 percent) was attributed to cropland. These data do not mean that soil erosion was not a problem on pasture or woodlands. Actually, the overgrazing of woodlands and pastureland led to serious erosion, particularly gully erosion, on these lands as well as cropland.

Table 1. Severity of erosion in Clayton County, Iowa, and Winona County, Minnesota, ca. 1934

Erosion degrees	Clayton County, IA [1]		Winona County, MN [2]	
	Acres	Percent on cropland	Acres	Percent on cropland
No apparent erosion	891	36	7,216	4
Slight erosion	2,560	82	195,541	32
Moderate erosion	3,258	90	122,763	81
Severe erosion	2,787	94	48,939	84
Very severe erosion	74	100	6,253	90
Totals, all degrees	9,840	85	374,712	56

[1] Data for Clayton County refer only to the Farmersburg-McGregor Project area. See U.S. Dept. Agriculture, Soil Conservation Service. 1942. *Physical Land Use Conditions on the.Farmersburg-McGregor Project, ClaytonCounty, Iowa (D.E. Perfect and D.A. Sheetz).* Physical Land Survey No. 28. 25pp.

[2] Data for Winona County refer to the entire county. See U.S. Dept. Agriculture, Soil Conservation Service. 1936. *Erosion and Related Land Use Conditions in Winona County, Minnesota (M. H. Brown and I. F. Nygard).* Erosion Survey No.17. 27pp.

A similar situation was reported in a county-wide field study for Winona County, Minnesota. About 55 percent of all erosion, but between 84-90 percent of the severe and very severe erosion was said to be on cropland. By degrees of erosion severity, total lands eroding and percentages occurring on cropland in Clayton and Winona Counties in the 1930s are in table l.

Comparable numerical estimates on cropland erosion are not available from early reports for the Coon Creek Project in La Crosse, Monroe, and Vernon Counties in Wisconsin, but serious soil erosion was said to occur because of the continued use of cropland, pasture, and woodland without regard for land capability or corrective conservation measures (USDA,1939,p.28).[4]

---

[4] For the ten sub-basins they studied, Trimble and Lund estimated annual gross erosion rates across all land uses of about 13.4 tons per acre under 1934 conditions, rates that had been reduced to 3.28 tons per acre by 1975 (Trimble and Lund,1982,pp.10-11). Specific estimates for cropland were not given.

1944 scene of stripcropping on Oscar Henkes farm near Farmersburg, Iowa, in the Farmersburg-McGregor Demonstration Project. Photo from Project files.

1995 repeat photo: Farm now owned by Lou Schrandt, showing that contour stripcropping is still being practiced. Photo by Douglas Helms, NRCS/USDA. August 1995.

Selection of Sample Counties

Information on erosion rates for different land uses and areas as of 1982, 1987, and 1992 are available from USDA's 1992 National Resources Inventory (NRI). Estimates of needs for erosion. control were also made in these NRI's, and also in those completed in 1958 and 1967. Findings of the 1934 Reconnaissance Erosion Survey (RES) and the successive NRI's are not directly comparable. The RES generally expressed erosion severity in terms of visible erosion problems, such as proportions of topsoil lost as of 1934, a 'state' condition. The National Resource Inventories have focused on current rates of soil loss and/or areas needing erosion control or other conservation treatments. To make the two appraisals comparable, it was necessary to research in some detail the land use and management practices that led to the serious conditions observed in the RES, using information for the decade 1925-35 from early soil surveys, localized erosion studies, agricultural censuses and other sources. Along with relevant soils and climatic data, these observations were used to 'reconstruct' erosion rates for a sample of five counties for the base year 1930, employing for this purpose the Universal Soil Loss Equation of Wischmeier and Smith (1978).

The five sample counties are not strictly a random statistical sample, but happen to be counties for which soil survey, erosion studies and other reports were available covering the decade 1925-1935, or five years on either side of the base year 1930. Soil and erosion surveys available for the 28 counties in MLRA 105 are identified in figure 1.

An initial plan was to select Clayton County, Iowa or perhaps Winona County, Minnesota for a pilot study. However, the study team concluded that the results would be more reliable and the research effort proportionately less if changes were analyzed for at least five sample counties, rather than for only one or two areas. The sample counties include: Clayton County, Iowa; Houston County, Minnesota; Winona County, Minnesota; Crawford County, Wisconsin; and Vernon County, Wisconsin. Trempealeau County, Wisconsin and Sauk County, Wisconsin were alternates.

For each of the five sample counties two soil or erosion survey reports have been completed since 1925 (figure 1). The first surveys were generally clustered during the period 1925-1935. In different levels of detail they described customary farming systems and practices during the years 1925-35 and so for the year 1930, the base year for the analysis. Data on crop and livestock production activity in the five sample counties and for the entire 28-county region were compiled for the base year 1930 and then for 1992 to indicate how well the livestock and crop production economies in the sample counties reflect those of the MLRA 105 region as a whole.

The land use and related information for the study drew on three important sources of information centered on the base year 1930: (1) The periodic (5-year) Censuses of Agriculture;

Before view of the Ed Kurth farm, Farmersburg, Iowa, Farmersburg-McGregor Demonstration Project, with terraces at top of the slope. Fields needed rearrangement for contouring and to eliminate gullied lane. Photo from Project files.

1995 repeat photo: Farm now owned by Lou Schrandt shows contour stripcropping and rearrangement of fences. Photo by Douglas Helms. NRCS/USDA. August 1995.

(2) annual crop reports compiled by State Agricultural Statisticians and the National Agricultural Statistics Services (NASS); and (3) cropping and/or management practices followed by farmers as observed in the field by soil or erosion surveyors.

Data on farm numbers, crops grown, livestock numbers, county populations, and income sources are mainly from the Censuses of Agriculture and/or Population (USDC,1927, 1931,1936,1994a,1994b). Additional information on annual crop acres, production and yields was obtained from reports and files of State agricultural statistical agencies, particularly for Illinois (1951), Iowa (1978,1981), and Minnesota (1994). Necessary background data on land uses and crops grown and crop yields in each sample county are in appendix tables A-1 through A-4.

Crop acres for 1930 and crop yields in the sample counties are in tables A-4 and A-5. The yield estimates are expressed as 'expected' rather than observed in the base year 1930, and are computed as averages during the decade 1925-1935. Yield levels and whether the residues are removed and how they are handled through tillage all influence erosion.

Land Use and Production Profiles

Cropping and other land uses for 1930 and 1992 for the five sample counties are consolidated and compared against all 28 counties in table A-1. In 1930 the principal field crops including rotation meadow (item B) were grown on about 71 percent of all croppable land in the sample counties and on 74 percent of the croppable land in MLRA 105. In 1992 this percentage was 79 percent in the sample and 83 percent for the region, even though cropland harvested (item D) relative to all land in farms did not change materially, remaining between 44-49 percent for the sample counties and from 47-51 percent for the general area.

Important changes did occur between 1930 and 1992 in the mix of principal crops. The area in rotation meadow increased by about 36 percent in the region, but by 68 percent in the sample counties. Row crops increased by over 130 percent in the region between 1930 and 1992 and by 91 percent in the sample counties. These increases were at the expense of decreases in small grains and by converting some new areas to cultivated cropland. The conversions were achieved by a reduction of 38 percent in cropland grazed, a reduction of 46 percent in permanent nonwooded pastureland, and some clearing of woodlands. These changes occurred despite a loss of land in farms between 1930 and 1992 of 16 percent in the sample counties and region (table A-1). Nonetheless, about the same proportion of all woodlands were grazed in 1930 in the region and the five sample counties, 81 and 87 percent, respectively (table A-2).

Importance of Pasture and Woodland Use for Livestock

In the five sample counties in 1930, the 574,000 acres of grazed woodlands represented almost two-thirds (63 percent) of the source of grazing land resources, compared with 47 percent in 1992.

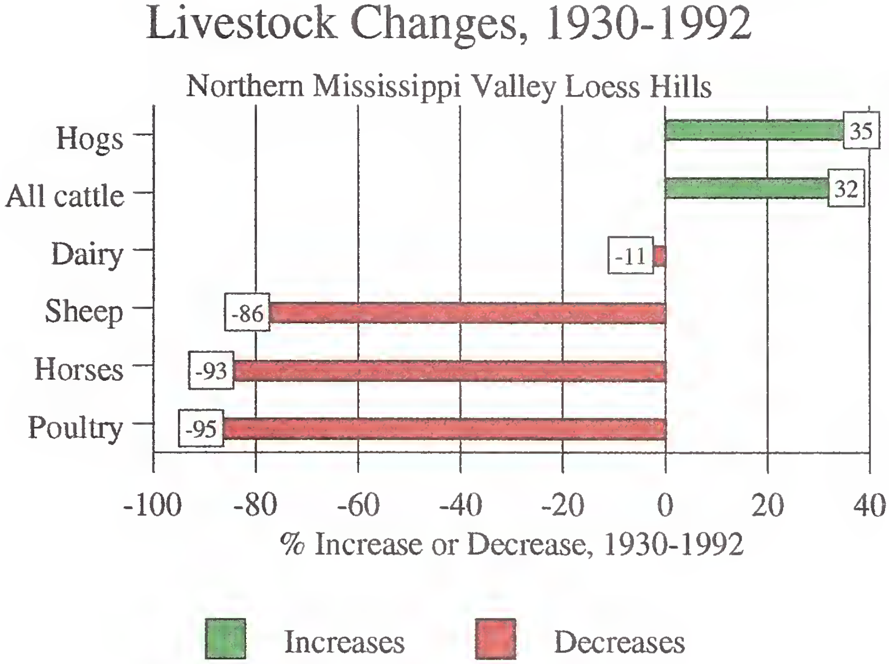
For the Coon Creek Basin in Wisconsin covering parts of La Crosse, Monroe and Vernon counties, Trimble and Lund estimated that 88 percent of the woodlands were grazed in 1934, dropping to 27 percent by 1974 (Trimble and Lund,1982,p.8). Our data indicate that the average proportion of woodlands grazed in just these three counties decreased from 80 percent in 1930 down to about 38 percent by 1992. Both sets of data indicate strong preferences in the 1930's for obtaining forages via grazing. Open and wooded pastures occupied large areas and had been grazed continuously for 50-70 years. Woodland grazing was very common, as was the overgrazing of permanent pastures. This not only caused serious sheet and gully erosion on the areas concerned, but also aggravated erosion problems on adjoining cropland.

Several factors help explain the dependence on pasture and woodlands: (1) The dairy farms required a good supply of forage. While there was a tendency to shift land from corn and small grain production to hay crops, this was done on a fairly limited basis. Other livestock farmers placed a relatively high value on cash crops and a low value on hay; (2) any hay needed was usually grown in rotation with corn or small grain feed crops if possible, rather than on permanent hay land; and (3) alfalfa was desired but was costly and in most areas alfalfa needed lime and fertilizer to get started properly. Its acreage was small and apparently limited to the best lands.

In 1992 only 45 percent of the woodlands were grazed in MLRA 105, compared with over 80 percent in 1930 (table A-2). Overall, the use of farms for grazing purposes has decreased by about 52 percent since 1930, by 64 percent on woodland as such, 45 percent for nonwooded pasture, and 37 percent for croplands previously grazed. These data reinforce the observations of Trimble and Lund that reduced woodland grazing and improved pasture management were important factors in controlling soil erosion in the Coon Creek sub-basins they studied

Figure 2 shows the relative change in numbers of various livestock from 1930 to 1992. Table 2 is a more detailed profile of the livestock economy in MLRA 105. Hogs and beef cattle inventories in the area have increased substantially; all other classes show large decreases. By 1992 the number of horses had declined to about 21,000 from the nearly 300 thousand reported on farms in 1930.

Figure 2



In 1930 about 85 percent of all farms in the area reported an average of 5 horses or mules.[5] The percentages were similar for the five sample counties and MLRA 105 as a whole. In those years much of the hay and other crops was needed to support the work stock. In the 1992 Census of Agriculture only 12 percent of all farms reported having horses, mules or ponies; the average in 1992 was also 5 per farm reporting.[6]

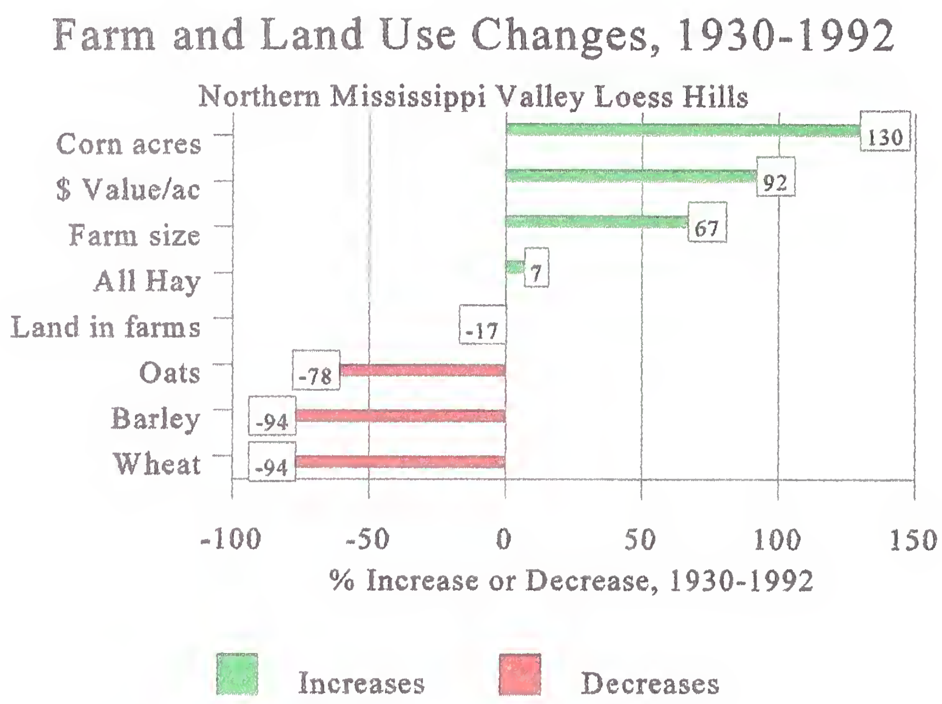
Though generally on the decline, dairying is still a major livestock industry in many counties but it is concentrated on fewer farms. Sheep and wool production have declined sharply, as have

---

[5] Rural counties in the 1930s arranged with some farmers to assist in road work, in exchange for waivers of poll taxes, in which case the farmer likely kept extra horses. Source: Mark Bowman and David Gibney. Interview with George A. Pavelis. Elkader, Iowa, 6 February 1995.

[6] The Census figures include only the horses reported by farmers, and so do not count so-called 'recreational' animals owned by nonfarm families. As of 1989 the Iowa Horse Council estimated there were 81,000 recreational horses in the State (Hendrickson,1995). In contrast, only around 47,000 horses or ponies were reported by all Iowa farmers in the 1992 Census of Agriculture.

Figure 3



farm flocks of poultry, but commercial poultry sales appear to have increased somewhat. The continued growth of the hog and cattle industries provides a ready market for local corn production.

Crops and General Economic Profiles

General changes in land use, crop distributions and other farm indicators are shown in table 3, also in figures 3 and 4. Details on land uses in 1930 in each sample county are in appendix tables A-3 and A-4. The number of farms in MLRA 105 and the sample counties fell by about 50 percent between 1930 and 1992. Average farm size in MLRA 105 has risen to 260 acres from the 155+ acres reported in 1930, while the area in farms has dropped by 17 percent.

Nominal (historical) real estate values for all counties of the United States from 1850 to 1982 have been compiled by Barnard and Jones *(1987)*. The inflation-adjusted (real) value of farmland for the 28 counties in MLRA 105 has almost doubled, from $375 per acre in 1930 to $720 per acre in 1992. Investments in machinery and equipment per farm in real terms were nearly 5 times as large in 1992 ($51,000) as in 1930 ($11,100). Farm tenancy has substantially declined.

Table 2. Livestock inventories and sales in 1930 and 1992 for five sample counties and all 28 counties in MLRA 105

Livestock by classes	Units	5 sample counties 1930	MLRA total 1930	MLRA total 1992	MLRA change 1930-92 [1]
Total number of farms	No.	12,891	71,048	35,230	-51
Livestock Inventories:					
1. Horses, mules, or ponies	1,000	52	298	21	-93
Per reporting farm	No.	5	5	5	0
2. Dairy cows and heifers	1,000	130	724	649	-11
Per reporting farm	No	10	11	50	35
3. Beef cows and heifers	1,000	5	38	283	645
Per reporting farm	No.	9	11	30	172
4. All cattle and calves	1,000	294	1,691	2,235	32
Per reporting farm	No.	NR	NR	90	--
5. Hogs and pigs	1,000	286	1,676	2,270	35
Per reporting farm	No.	NR	NR	310	--
6. Sheep and lambs	1,000	60	455	64	-86
Per reporting farm	No.	NR	NR	40	--
7. Chickens, 3+ months old	1,000	1,138	6,880	313	-95
Per reporting farm	No.	92	105	245	134
Selected Sales Data: [2]					
8. Cattle and calves sold	1,000	NR	NR	1,091	--
Per reporting farm	No.	NR	NR	45	--
9. Hogs and pigs sold	1,000	NR	NR	4,189	--
Per reporting farm	No.	--	--	555	--
10. All chickens sold	1,000	802	4,841	12,813	164
Per reporting farm	No.	82	90	50,000	--

Source: Censuses of Agriculture for 1930, 1935 and 1992.

[1] Data in this column are the total percentage changes between 1930 and 1992.

[2] See table 6 for gross incomes from crops, livestock and livestock products.

NR = not determinable as such from the 1930 Census. -- less than 1 head or less than 1 percent.

Table 3. General economic and crop production profiles for 1930 and 1992 for five sample counties versus all 28 counties in MLRA 105

Economic and crop items	Units	5 sample counties 1930	MLRA total 1930	MLRA total 1992	MLRA change, 1930-92 [1]
Number of farms	No.	12,891	71,048	35,230	-51
Total land in farms	1,000 ac	1,990	11,067	9,185	-17
Average size of farm	Acres	154	156	254	62
Real estate value per acre [2]	Dollars	\$350	\$375	\$720	92
Equipment value per farm [3]	Dollars	\$11,100	\$11,100	\$51,000	365
Cropland tenancy ratio	Percent	32	34	12	-22
Total value of product sales [2]	\$millions	178	982	2,770	182
1. Crops, fruits, plants	Percent	55	51	18	-33
2 Livestock and products	Percent	45	49	82	+33
Total harvested cropland	1,000 ac	867	5,155	4,789	-7
Principal crops harvested:					
Hay/chop, except corn silage	1,000 ac	359	1,687	1,812	7
Alfalfa only	1,000 ac	15	112	1,519	1,256
Corn for all purposes	1,000 ac	216	1,128	2,492	120
Soybeans for beans	1,000 ac	--	--	184	--
Oats for grain	1,000 ac	180	1,172	258	-78
Barley	1,000 ac	59	395	22	-94
Wheat for grain	1,000 ac	14	83	4	-94
Irish potatoes	1,000 ac	7	29	25	-14
Vegetables	1,000 ac	11	15	44	193
Tobacco	1,000 ac	11	15	3	-80
Land in orchards	1,000 ac	4	18	6	-67

Sources: Censuses of Agriculture for 1930 and 1992.

[1] All data in this column are in total percent change between 1930-1992.

[2] All land values and product sales expressed at 1992 price levels, using a 1930/1992 deflator for the U.S. gross domestic farm product (1992 index = 100; 1930 index = 20.6).

[3] Equipment values expressed at 1992 price levels, using a 1930/1992 U.S. deflator for purchase of durable farm equipment and tractors (1992 index = 100; 1930 index = 9.70).

In 1992 only 12 percent of the harvested cropland was farmed by tenants who farmed none of their own land, compared with 34 percent in 1930.

The farm economy of MLRA 105, as measured by product sales, remains livestock oriented. In 1992 about 82 percent of gross sales were from livestock or their products, compared with about 50 percent in 1930 (table 3). Crops showing large gains between 1930 and 1992 include alfalfa, corn, soybeans and vegetables. Those losing importance were the small grains and tobacco. In 1992 there were about 184,000 acres of soybeans grown for beans. A few soybeans were grown in 1930 but they were used almost entirely as an emergency hay supply. Soybeans are now a common oilseed crop in the Midwest and other regions, and are an alternative to corn and other field crops, depending on relative prices and production costs for the alternatives.

To examine how typical the land uses patterns in the five sample counties were of the 28-county region in 1930, a paired t-test was made. Two sets of 20 acreages, in 5 row crops, 3 small grains, 5 rotation meadow options and 7 other 'independent' land uses, like pasture and woodlands were compared, taking each acreage item as a percentage of all cropland harvested in each county group. It was concluded that land uses in 1930 in the five sample counties were a very good representation of land use throughout the 28-county MLRA 105. The similarity in 1930 as well as in 1992 of the relative distribution of the main crops in the sample counties and the region is evident in figure 4.[7]

This test and conclusion are important because the distribution of the various crops, associated tillage practices and methods for handling crop residues across the different counties and soils in the region also determines the distribution of values for the cover-management factor **C** in the Universal Soil Loss Equation.

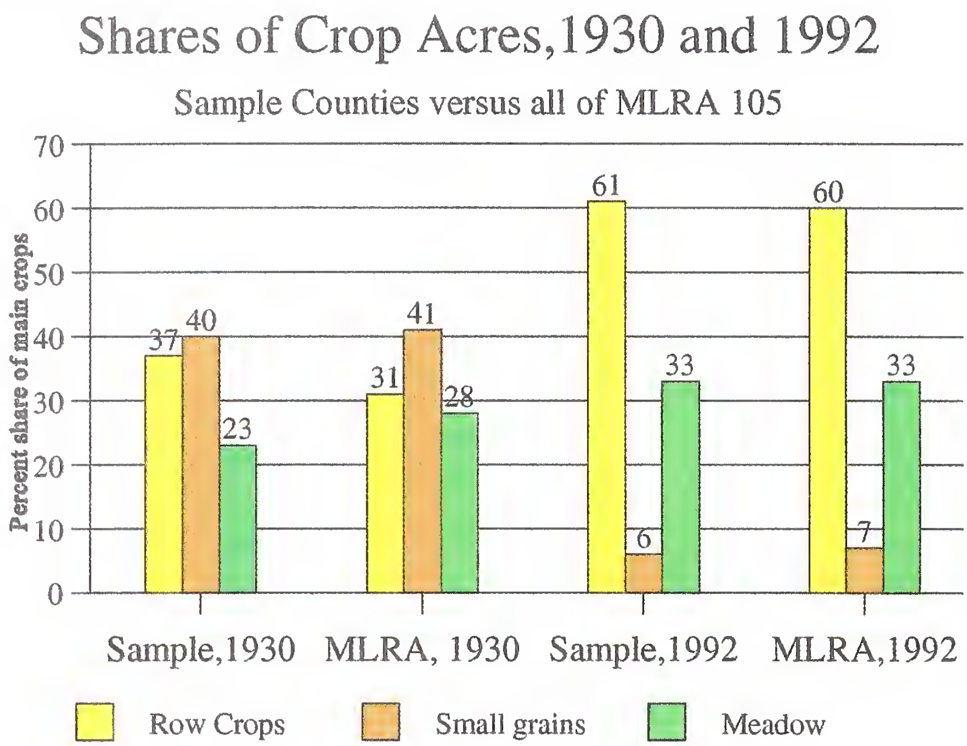
Early Farming Systems Related to Soil Erosion

This review condenses sample county information in soil survey, census and other documents generally dated for the period 1925-1935. Some observations are from soil surveys for

---

[7] Assuming that each of the 28 counties in MLRA 105 had an equal chance of being included in either the five sampled or the 23 nonsampled counties (having an equal likelihood of having soil surveys done between 1925-35), a t-statistic was used to test the null hypothesis that in 1930 there was no relative difference between the land use patterns of the five 'sampled' and the 23 'nonsampled' counties. The calculated t-statistic, for 19 degrees of freedom, was 0.987, compared to a tabular value of 2.093 for the 95-percent level of confidence. In this case the hypothesis is not rejected.

Figure 4



other counties in MLRA 105, including nearby Dubuque and Clinton Counties in Iowa and Trempealeau County in Wisconsin. The principal soil or erosion surveys reviewed include those of Benton and Gray (1925), Brown and Nygard (1936), Edwards with others (1928,1930), Gray with others (1929), Perfect and Sheetz (1942), and the Coon Valley report of the Soil Conservation Service (1939).

Crop Selection and Rotations

In this area of narrow dissected valleys nearly all farms in 1930 included some land unsuited to tilled crops. This meant that nearly every farm had land that was left as pasture or woodland. This disproportion of land uses, together with some uncertainty of corn as a reliable crop, helps explain farming practices of the period. However, corn remained the most profitable crop to grow except for tobacco, which was limited mostly to some Wisconsin counties. Aside from avoiding cultivation of the steepest land, over much of MLRA 105 in 1930, corn was grown as often as possible without regard to surface relief. However, only enough corn to feed livestock was produced on the ridge farms because the cultivation of corn led to erosion. As this feature was too serious to ignore, corn

was grown on a fairly small acreage in hilly areas. Where it was felt that corn had to be grown it was kept out of the rotation as long as possible.

These points indicate that most farmers in the area were aware of the hazards in cultivating the highly erosive slopes. They tended to choose crops accordingly. On the other hand, erosion attributable to the tillage and harvesting methods of the time, like thorough plowing, cultivation and residue removal after harvesting were not fully understood.

Information on crop rotations varied considerably among the soil survey and other literature. Some sudies gave no information on the rotations follwed. However, one rotation commonly mentioned as widely practiced was one year of corn (C), followed by a year in oats or other small grain (G), followed by a year of meadow (M), with the meadow being seeded in with the oats, or CGM. A second fairly common rotation was CCGM.

Corn was seldom grown continuously and then only on the best land or on small tracts on hill farms. Several soil surveys indicated that systematic rotations were not commonly practiced, but the meaning of 'systematic' was unclear. Rotation meadow was usually cut for hay until turned under, but was sometimes used as green manure in years of abundant rain and other hay. Many farmers were said to feel from experience that long rotations involving meadow could not be carried out successfully. Hay was left in as long as possible as forage. Farmers preferred cash crops like tobacco and corn over hay.

Rotations involving corn were generally limited to the smoother lands and not put on the hilly sections because of the difficulty in cultivating steep slopes as well as their susceptibility to erosion. The somewhat uneven and scattered information on rotations common in MLRA 105 in the 1925-35 period leads one to conclude that the most common rotation involving corn was CGM (C=corn, G=any small grain, M=meadow). The Crawford County Soil Survey indicated that rotations on the relatively level valley soils frequently alternated corn only with meadow, such as CCMM or CCCMM. Corn was avoided on fairly sloping ridgelands, with small grains, mainly oats, alternated with meadow, as in GGM or GGMM.

There was evidence in some reports that the failure to follow crop rotations led to serious weed problems. Check-row planting of corn was practiced for weed control and improved water absorption, but the necessary partial cultivation with slope tended to aggravate erosion problems, especially during the early cultivations.

Soil Management Problems

Commercial fertilizers were not commonly regarded by farmers as being necessary for profitable production, and liming was not generally practiced. An important exception was Crawford County where limestone quarries were nearby and commercial fertilizer was used. Barnyard manure was generally considered the best fertilizer. It was valued as much for promoting good tilth as for maintaining fertility.

Crawford and Vernon Counties in Wisconsin had extensive acreages in tobacco. The manure was apparently used first on tobacco, a good cash crop, and then on corn, potatoes and vegetables, apparently in that order. The small grains and hay were seldom fertilized, except that manure was sometimes used to get legume hays started. Barnyard manure was almost the only fertilizer used in many areas, but there was also some turning under of green manures, including green rye, especially on sandy soils.

In Vernon and other counties alfalfa was appreciated as a crop, but because of the high price of seed and the liming and fertilizing requirements, alfalfa was not commonly grown at the time. Hay crops were usually left in as long as possible to provide forage.

Tillage and Crop Residue Practices

The sample and other counties were similar with regard to these practices. Tillage operations were generally thorough. This was partly attributed to the high price of land. This encouraged the intensive cultivation of any additional land purchased. The customary practice was to plow as much land as possible either in the late summer or fall. Corn land was plowed in the fall if the weather permitted, otherwise not until just before spring planting. Straight furrows were considered a source of pride and the mark of a good farmer.

When oats were to follow corn, about half the land planned for oats was plowed and the rest disked. Entire fields were plowed at the same time if possible, especially on the ridge farms. Plowing and subsequent cultivation with the slope caused tremendous losses of soil. The removal of crops and residues was common, leaving only stubbles. In the early years, however, even the burning of stubbles was common, because it was difficult to turn it under with the equipment of the time. Soil losses in the fall and from the spring snowmelt were very heavy, as the corn fields were nearly bare after being harvested for grain or shredded for stover.

<u>Harvesting Methods for Corn</u>: For corn the Censuses of Agriculture for 1925, 1930, and 1935 separately reported by counties the acres harvested for grain, those cut for silage or fodder, and those hogged off or with the standing crop grazed. The 1925-35 ten-year averages overall for the

five sample counties were: 64 percent harvested for grain, 26 percent cut for silage or fodder, and 10 percent hogged off.

Harvesting of Small Grains: For small grains like oats, wheat, barley and rye, other than the acres occasionally cut early for hay, the common practice was to harvest for grain, and remove the straw, leaving only the stubble. Combines were not yet marketed in the area. The small grains were generally cut with binders, shocked, and centrally threshed, probably on a custom or cooperative basis, and most likely in the fields or near the buildings. The straw stacks may have been used directly or baled and then stored or sold. In any case, the fields were left as stubble and fall-plowed as soon as possible, if not already seeded to meadow.

Conservation Efforts

Common conservation techniques like contouring, terracing and strip cropping were seldom practiced in MLRA 105 prior to the establishment of Federal and State technical assistance and cost-sharing programs. However, it appears that farmers of the time generally did avoid cultivating their highly erodible land. Cropping patterns were determined largely by soil and slope conditions, within the needs of the farm for grain and forage crops. The soil survey reports for both Crawford and Trempealeau counties in Wisconsin indicate that there was little cultivation on slopes exceeding 14 percent. On the other hand, because of their tendency to lodge under excellent growing conditions, small grains like barley and oats were not commonly grown on the level well-drained soils.

Any alfalfa was usually grown on the best land. Alfalfa seed was costly and in most areas legumes were difficult to get properly established without the addition of lime and commercial fertilizer. The alfalfa also eliminated the possibility of corn on the field for a few years. This encouraged planting corn on the steeper slopes and on the same field for several years. Little attention was given slopes in laying out fields on almost all farms. Corn rows were typically the long way of the field, regardless of slope. Some farmers blocked open furrows with chunks of sod to keep water from following the furrows.

By present standards conservation measures of the time were limited both in scope and effectiveness. Some farmers planted grassed waterways, but they were too narrow to be fully effective. Deposits of silt in the grass soon formed a ridge and caused cutting along the sides. Some of the valley slopes were worked on the contour and in alternate strips of hay and grain crops. The strips were usually straight, though sometimes as close to the contour as possible without being laid out with an instrument. Attempts were also made to reduce soil loss by contour harrowing the fields seeded to grain, with the last cultivation made on the contour if possible.

The Coon Creek project report involving parts of Vernon, La Crosse and Monroe counties in Wisconsin relates that two farmers in the area had terraces. Both systems had been established with the help of the Extension Service. The terraces were small but effective and natural grass waterways were used for outlets. The value of terraces for erosion control was recognized by both the owners of these two farms and their neighbors.

In Crawford County to the south the Soils Department at the University of Wisconsin had constructed experimental 'Mangum' terraces on several fields in the county as active demonstrations. Their ridges were low and smooth enough for easy use of ordinary implements.

There were efforts to control gullies. Some farmers tried to divert water away from gullies by plowing furrows from the edge to each side. In a few cases small dams of loose rock, logs or lumber were constructed. They were generally ineffective because they did not catch the lip of the gully, and failed to stop its advance. To make small gullies crossable with implements, they were sometimes filled with straw, brush, manure, logs, or rocks and then the sides were plowed in.

Some gullies were caused by water from road ditches and culverts rather than by farming methods, especially where there was a drop to a nearby gully or lower land. To protect the road from undermining, the highway departments often used a metal flume to take and lower the water to a safe distance from the road. However, little attention was given to preventing erosion at the outlet of the flume and much soil was carried away by water from roadways.

Estimating Cropland Soil Erosion

Estimates in this study of expected average annual erosion rates on cropland involve, for 1930, 1982 and 1992, applications of the Universal Soil Loss Equation (USLE). Details of the USLE procedure are documented by Wischmeier and Smith, principally in their Agriculture Handbook No.537 on Predicting Rainfall Erosion Losses (Wischmeier and Smith,1978). Hereinafter this classic reference will be called Handbook 537. An earlier journal article by Wischmeier (1976) discusses the advantages and pitfalls in applying the method in particular kinds of problems.

The estimates of average annual erosion rates for 1982 and 1992 have been obtained directly from the 1992 National Resources Inventory (NRI) and to some extent from the 1982 NRI. These Inventories are completed at 5-year intervals by USDA's Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (USDA,1962,1971 and 1987).

The National Resources Inventories are a comprehensive source of national, regional, State and county-level data on such numerous variables as land ownership, land uses, management practices such as irrigation, as well as detailed information on water-related and wind-related soil

erosion and associated treatment needs and practices. The NRI estimates for 1992 were based on observations at about 800 thousand randomly selected sample points located across the United States. Results are judged to be statistically reliable at a national level and for States, broad regions, and sub-State areas other than individual counties. National-level results for 1992 are summarized by Kellogg and associates (Kellogg, TeSelle and Goebel, 1994). A review of USDA's similar inventories and a detailed explanation of the sampling techniques employed in recent inventories is in another USDA report (Goebel, 1992). For our study area the NRI estimates for 1982 and 1992 are based on USLE factor values for 1,945 sample points within the five sampled counties, and for 12,057 sample points within all 28 counties predominantly in MLRA 105.

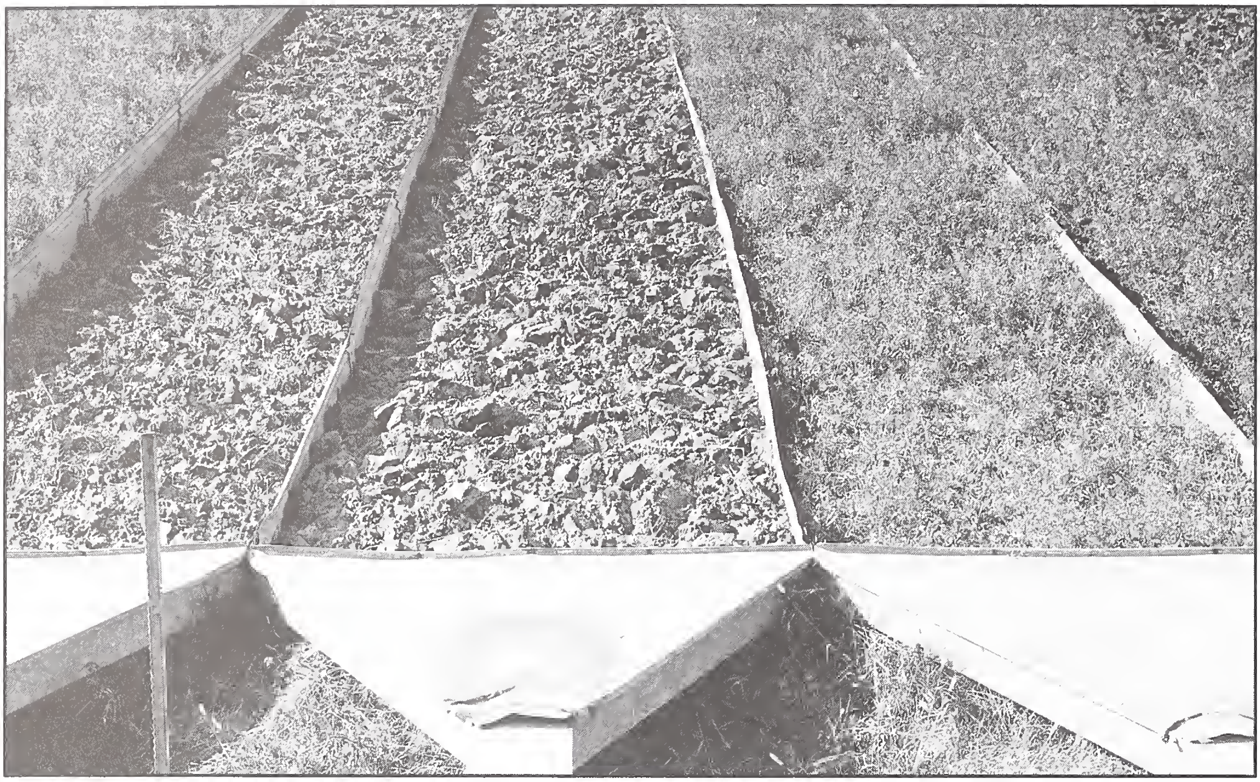
Some Prior Applications

Wischmeier and Smith pointed out that the reason for having a systematic method for estimating rates of soil loss, such as the USLE or suitable alternative methods, is to rationalize decisionmaking for conservation planning on a site basis. The method enables planners to predict the magnitude of erosion under different climatic and soil conditions as well as alternative cropping systems, management techniques, and conservation practices (Wischmeier and Smith,1978,p.3). The USLE is used to estimate water-related sheet and rill erosion. Estimates of wind-associated soil erosion and of gully erosion induced by concentrated water flow involve other factors and methods.

In 1986 the Economic Research Service completed a national-level analysis of the erosion-control costs and benefits of the USDA's Conservation Technical Assistance, Great Plains and Agricultural Conservation Programs (Strohbehn,1986). The physical measures of sheet and rill erosion were based on the USLE; data for wind erosion were based on methods developed by Chepil and associates at USDA's Wind Erosion Research Unit at Manhattan, Kansas (Lyles,1985).

An application of the USLE methodology in assessing the physical and economic impacts of alternative soil conservation practices and policy options for reducing soil losses to given tolerance levels, has been completed for eight representative farms in southeast Minnesota that happen to be in MLRA 105 (Padgitt,1980). Prospective erosion control benefits for 448 conservation plans in 30 sampled counties in Alabama, North Carolina, South Carolina and Tennessee were analyzed by Grubb and Tolley (1966), using a preliminary version of the USLE.

A previous interdisciplinary study for a watershed in the Missouri loessial region in western Iowa predated the availability of the USLE, but was based on a similar rational soil loss formula, called the "Browning Factors" (Schwab with others,p.122ff). The objective of the Iowa team study was to apply engineering and agronomic principles in reconciling the economic interests



Runoff check plots at the Upper Mississippi Valley Experiment Station, LaCrosse, Wisconsin. Information from such experiments was used to develop the Universal Soil Loss Equation. NRCS/USDA photo. (Wisconsin 76,351).

of farmers who controlled watershed uplands with the objectives and plans of other onsite or offsite public agencies affected by watershed land uses (Pavelis with others,1961).

The later work of Trimble and Lund in Wisconsin (1982) applied the USLE to determine changes between 1934 and 1975 in erosion, as well as the reductions in reservoir and valley sedimentation associated with land use and management practices in 10 sub-basins totaling about 8 thousand acres within the Coon Creek Basin. This is an area of 49,400 acres involving parts of La Crosse, Monroe and Vernon Counties. It was the first conservation demonstration project established by the Soil Conservation Service (USDA,1939 and Helms,1982a).[8]

---

[8] For the period 1934-1975 Trimble and Lund determined that there was an overall reduction of nearly 75 percent in the average annual erosion rate per acre in the 10 sub-basins they studied (Trimble and Lund,1982,p.10). They attributed the reductions to substantially decreased grazing of woodlands, more meadow in crop rotations, and the adoption of conservation practices, especially contour stripcropping.

Anticipating the Universal Soil Loss Equation

The serious soil erosion problems observed in the early 1930's were the result of several factors: (1) Crop selection and land use methods not consistent with the capabilities of soils to produce sustained yields; (2) soil management problems specific to the area and indirectly if not directly related to potential erosion; (3) the absence of regular crop rotations where needed; (4) the tillage and residue management practices followed; and (5) the absence of now generally recommended conservation practices.

The importance of these factors along with climatic considerations was aptly summarized by Perfect and Sheetz in their survey in the 1930's of conditions on the Farmersburg-McGregor Project in Clayton County, Iowa. The USLE embodies many of their concepts of how soil erosion can occur:

> "The factors contributing to erosion are climate, the nature of the soil, the slope of the land, the existing and former land uses, and the agricultural methods employed in the tillage of the soil. Of the various climatic factors, the amount and intensity of rainfall have the most effect on erosion.
>
> "There are three periods during the year in which erosion losses are extensive. The first comes with thawing snow in the early spring. Most of the snow that falls in the winter remains on the ground until the spring when it melts rapidly. As much of the ground is without any vegetative cover at this time, the loss of soil in the runoff water resulting from the melted snow is enormous. Heavy rains during the spring at the time of seedbed preparation remove large quantities of topsoil, as the soil is usually worked to such an extent that it is broken up into fine particles that are readily washed away.
>
> "The third critical period occurs in the summer following hot, dry weather during which the soils become almost powdery dry. Intense rains falling on the loose, dry topsoil wash away large amounts of the soil". (Perfect and Sheetz,1942,p.22).

Applying the USLE to 1930 Conditions

The Universal Soil Loss Equation (USLE) is grounded in many years of soil and water conservation research, being based on over 10,000 plot-years and 500 watershed-years of observations on precipitation, soil loss and related field and cropping situations (Meyer and Moldenhauer,1985). The equation first evaluates factors for rainfall and runoff (**R**); soil erodibility (**K**); slope length (**L**); slope steepness (**S**); cover and management (**C**); and supporting conservation

practices (**P**). The estimated average annual erosion rate for a given cropping situation is then computed as:

A = R K L S C P

Definitions for each USLE variable are repeated from Wischmeier's and Smith's Handbook No. 537 (1978,p.4):

A is the computed soil loss per unit area, expressed in the units selected for **K** and for the period selected for **R.** In practice, these are usually so selected that they compute **A** in tons per acre per year, but other units can be selected.

R, the rainfall and runoff factor, is the number of rainfall erosion index units, plus a factor for runoff from snowmelt or applied water where significant.

K, the soil erodibility factor, is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot, which is defined as 72.6 feet in length and having a uniform slope of 9 percent, continuously in clean-tilled fallow.

L, the slope-length factor, is the ratio of soil loss from the field slope length to that from a 72.6-ft length under identical conditions.

S, the slope-steepness factor, is the ratio of soil loss from the field slope gradient to that from a 9-percent slope under otherwise identical conditions. In practice **L** and **S** can be combined as a single topographic factor **LS** (not a simple product).

C, the cover and management factor, is the ratio of soil loss from an area with specified cover and management to that from an identical area in tilled continuous fallow.

P, the support practice factor, is the ratio of soil loss with a support practice like contouring, stripcropping, or terracing to that with straight-row farming up and down the slope.

In the erosion analysis that follows it is assumed that conservation measures like terracing, contour farming and stripcropping were at best developmental in nature and not practiced widely enough in the sample counties or in the region to be assigned a factor value for **P** of less than 1 in the USLE, the value for straight row farming up and down the slope. While supporting tillage or other conservation practices had not yet been adopted on a significant scale, farmers were conservation-minded to the extent that, recognizing potential erosion hazards, crops were selected with reference to soil suitability and slope conditions.

Values of **R**, **K**, **L**, and **S** needed for the MLRA 105 analysis were provided by soil scientists from climatic and soils data. As noted above the factor **P** could be assigned a value of 1.

Regarding the cover and management factor **C**, the early soil surveys and Census reports were used to help identify the crops grown and/or the crop sequences likely followed on cropland soils in the five sample counties for the base year 1930. The distributions of crops and/or rotations across major soils used for crops in a given year or period were used to estimate average values for the cover-management factor **C**. Several kinds of specific information were needed to derive values for the **C** variable itself:

Possible Crop Sequences

According to soil survey reports and other publications for the period 1925-1935 about 17 primary crop rotations, excluding continuous cropping, were used in MLRA 105 in 1930. All were possible candidates for determining approximate values for the USLE factor **C** in the year 1930. They are listed with reference to the particular crops that may be involved:

Corn with small grains only (4): CG, CCG, CGG, CCGG

Corn with small grains and meadow (7): CGM, CCGM, CGGM, CGGMM,
CCCGM, CGMM, CCCGMM

Corn with meadow only (3): CMM, CCMM, CCCMMM

Small grain with meadow only (3): GM, GGM, GGMM, and where:

C = Corn, including corn for grain, corn silage, and corn grazed;

G = Close-grown small grains, mostly oats but also wheat, barley, and rye;

M = Meadow, including clover-timothy mixes, clover alone, timothy alone, alfalfa, legume and grass seed crops, and annual legumes taken for hay.

Subsistence or cash row crops like potatoes, vegetables, and tobacco rotated with corn or small grains were also included for analysis. The tobacco likely received priority for applications of barnyard manure.

Crop Yield Levels

The acres in each principal crop for each sample county in 1930 have been compiled from the Census of Agriculture and other sources (table A-4). Yield levels (table A-5) for the base year 1930 were computed on an 'expected' basis, as 10-year averages from 1925-35. Annual data from State statistical offices were used if available, otherwise data were averaged from the Censuses of Agriculture for 1925,1930 and 1935, or from observations made in county soil surveys completed during the same period (table A-5). While yields from field to field doubtless varied, depending on soil productivity and the crop rotations, all are believed to fall within the range defined as Low

Productivity (LP) in Agriculture Handbook 537. In the rotations above, the greatest corn yield would be expected in the first year following meadow, the next highest in the second year following meadow, and lowest three or more years after meadow.

Tillage Systems

Modern conservation tillage technology did not exist in 1930. The moldboard plow was the primary tillage tool. In some cases where spring-planted crops followed corn, the land was disked to prepare the seedbed. Three general tillage alternatives were used at the time: (1) Fall moldboard plowing, with secondary tillage in spring, followed by seasonal cultivation as necessary for corn or other row crops; (2) spring moldboard plowing, secondary tillage and/or cultivation; and (3) spring disking.

Tillage systems for specific crops in 1930 involved various combinations of the three general types. Those chosen for this study appeared reasonable from the literature of the period and recollections of individuals familiar with agricultural methods of the time.

Selected 'C' factors for tillage options for each crop within rotations of varying length for Clayton County, Iowa as an example are given in table A-6. Note that the factors vary with the prior crop, the number of seasons a crop was continued, the time and method of tillage, and the method of harvesting as related to the amount of residue left in the field.

Crop Residues

Published sources indicated that removing crop residues for roughage or bedding, or by grazing, was a common but not universal practice in 1930. Five residue management situations were accordingly examined: (1) Harvest for grain, residue left and returned to the soil by moldboard plowing or disking; (2) Harvest for silage, remaining stubble returned to the soil by moldboard plowing or disking; (3) Harvest for grain, stover or straw removed for roughage or bedding; (4) Harvest for grain, residue grazed by hogs; and (5) Standing crop grazed by hogs.

<u>Residue Management for Corn</u>: In the case of corn, the 1925, 1930, and 1935 Censuses of Agriculture reported by counties the acres harvested for grain, those cut for silage or fodder, and those hogged off or left standing for grazing. For these three Census years an average of 64% of the corn in the five sample counties as a group was reported as being harvested for grain, 26% was reported taken for silage, and about 10% was reported grazed or hogged off. Because the Census reports were silent on whether crop residues were removed, some additional assumptions were necessary.

The cover-management factors for corn sequences in the USLE calculations represent average conditions. They assume that 50% of the corn was harvested for grain with residues left, 40% was harvested for silage (residue considered removed), and 10% was grazed, either as a standing crop or after harvest for grain. This implies partial removal of residues. For corn these weights further assume that residues were left for 80% of the corn harvested for grain, and removed for the remaining 20%. Residues were almost completely removed if the corn was taken for silage or if stover was removed after harvesting for grain. These percentages were used to obtain weighted mean 'C' values for corn sequences given in table A-6.

Residue Management for Small Grains: For small grains like oats, wheat, barley and rye, a single residue management option was assumed: " Harvest for grain, with straw removed after harvest, leaving only stubble". Because combines were not in use, straw was not distributed over the field. The grain was bound, shocked, and transported to a stationary threshing machine. Appropriate 'C' factors for small grain sequences have also been provided (table A-6).

Cropstage Dates

Data for planting and harvest dates, and dates of selected crop canopy levels, were available at the Midwest National Technical Center (MNTC) of USDA's Natural Resources Conservation Service (NRCS). These data were initially developed by Hayes about 1978, then updated and refined by Argabright and Lightle to reflect conditions of the 1980's and 1990's. Their estimates are adjusted to reflect 1930 conditions:

Cropstage F, Rough Fallow Period: MNTC dates were used with no change.

Cropstages SB, 1, and 2, Seedbed Establishment and Development: MNTC dates were adjusted to reflect slower canopy closure due to lower plant populations, wider rows, and lower biomass production associated with less fertilization and unimproved corn varieties.

Cropstage 3, Maturing Crop Period: Low canopy levels were assumed, to reflect the low productivity yield levels of table A-5. An 80-percent canopy cover was assumed, consistent with Low Productivity corn.

Cropstage 4, Stubble Period: Soil loss ratios for this period reflect the fact that removal of residues for roughage or bedding was a common practice in 1930. For those systems where the corn residues were left on the field, soil loss ratios were from Agriculture Handbook 537 for Cropstage 4L (residues left partially standing, not shredded or spread). This reflected field conditions following husking by hand or harvest with early mechanical pickers.

Cropland and Crop Classifications

These were developed in this study to help match the soils in each county by land use capability class/subclass (LCC) to cropping sequence groups. The major land capability classes I, II, III and IV are generally usable for cultivated crops, but Classes II, III, and IV may have limitations such as erosion hazards (subscript e), excess wetness (subscript w), soil limitations (subscript s), or climatic limitations (subscript c). The LCC classification was developed by the Natural Resources Conservation Service (formerly the Soil Conservation Service) of the U.S. Department of Agriculture (Klingebiel and Montgomery, 1961).

A first consideration was that the various crop rotations followed in 1930 were not uniformly distributed over the soil groups. Rotations having high values of **C** were assumed more likely followed on the better soils.[9] The rotations having lower C values were more likely followed on soils having greater erosion or other hazards and more limitations for production.

For example, we assumed that in 1925-35 the rotations involving minor row crops and intensive corn production (Crop Groups A and B) would have occurred mainly on the soils in land use capability subclasses I, IIe, and IIw. Group C sequences (generally two-crop small grain/meadow rotations), having intermediate values of '**C**' ,were assumed to occur mostly on were more likely to occur on soils in capability subclasses IVe, IIs, IIIs, and IVs. Three-crop corn/small grain/meadow rotations (Group D) were assigned to the capability subclass IIIe lands. Adjustments were made to this general pattern as needed to reconcile calculated crop acres with the reported Census data for 1930.

Approximating 'C' factors under conditions in 1930 required that the main crops grown and any rotations followed correspond well with the available croppable soils as well as with the number of acres of each crop grown in1930.

Crop acres as published in the 1930 Census of Agriculture were used as statistical controls. They are recorded for each sample county and crop in table A-4. They were matched to available cropland on the basis of land use capabilities. Four cropland/crop groups were defined:

---

[9] This may appear contradictory in that, other factors equal, higher **C** values mean greater erosion, but recall that corn or other row crops were grown frequently on the better soils. This ordinarily involved moldboard plowing, clean cultivation and residue removal, all of which left the fields vulnerable to rapid snowmelt and rainfall erosion.

Table 4. Soils and crop groups by land use capabilities in sample counties in MLRA 105, 1930

Soil and Crop Groups	Clayton County, Iowa	Houston County, Minnesota	Winona County, Minnesota	Crawford County, Wisconsin	Vernon County, Wisconsin	Totals, 5 sample counties
Land Use Capability Classes and Subclasses, by Percent Used for Principal Crops[1]:						
Class I	90	65	70	90	60	76
Subclass IIe	90	65	70	90	60	71
Subclass IIw	90	44	45	60	35	50
Subclass IVe	60	35	45	36	30	35
Subclass IIs	60	35	45	36	35	48
Subclass IIIs	60	35	45	36	30	45
Subclass IVs	60	35	45	36	30	45
Subclass IIIe	81	45	61	65	46	64
County averages	79	47	62	45	39	55
Principal Crop Groups, by Land Use Capability Classes (data in acres) [2]:						
Crop Groups A and B:	58,000	43,800	79,700	10,3003	28,800	220,600
Class I, IIe	39,800	34,400	76,650	7,100	24,100	182,050
Subclass IIw	18,200	9,400	3,050	3,200	4,700	38,550
Crop Group C.	11,900	20,550	17,400	42,950	44,675	137,475
Subclasses IVe, IIs,	11,900	20,550	17,400	42,950	44,675	137,475
Crop Group D .	149,100	30,150	50,000	19,850	40,125	289,225
Subclass IIIe	149,100	30,150	50,000	19,850	40,125	289,225
All Groups/Uses,1930[3]	219,000	94,500	147,100	73,100	113,600	647,800
Vegetables	2,300	600	1,000	300	700	4,900
Irish potatoes	1,400	1,000	2,100	800	1,400	6,700
Tobacco	--	--	--	2,400	8,900	11,300
Corn	86,400	35,200	36,000	26,800	31,200	215,600
Small grains	75,500	35,800	74,600	26,100	47,800	259,800
Rotation meadow	53,400	21,900	33,400	16,700	23,600	149,000

[1] Percentages of total county acreages in given capability classes estimated as available for main crops in 1930.
[2] Acres have been estimated by applying the percentages above to all land in the given capability classes.[3] Crop acreages as reported in the 1930 Census of Agriculture and in some State crop reports for 1930.

Cropland Group AB

Cropland group AB was assumed suitable for A, minor row crops and B, relatively intensive or frequent corn production. Group AB included all Class I land and land use capability subclasses IIe and IIw. For example, in 1930 group AB included 58,000 acres in Clayton County, Iowa; 79,700 acres in Winona County, Minnesota; 28,800 acres in Vernon County, Wisconsin; and 220,600 acres in all five sample counties (table 4).

Group A--Minor Row Crops

Crop Group A included the minor row crops of Irish (white) potatoes, vegetables, and tobacco, assumed grown only on the best soils, with tobacco having first priority for the addition of barnyard manures. Of the five sample counties, for the most part tobacco was and is limited to Crawford and Vernon Counties in Wisconsin.

Again using Clayton County as an example, group A included the 2,300 acres vegetables and 1,400 acres of Irish potatoes, with half the acres in each alternated every other year with either corn or any small grain. This means that about 1,850 acres of corn and also 1,850 acres of small grains were estimated as rotated with the minor row crops in 1930, of which 1,150 acres were alternated with vegetables and 700 acres with potatoes. Details on such allocations are illustrated for Clayton County in table A-7. A total of 7,400 acres of the 58,000 acres of cultivatable cropland in capability class I and subclasses IIe and IIw in cropland group AB were required for the rotations involving vegetables and potatoes, leaving 50,600 acres available for rotations of corn with small grains or meadow.

Group B--Intensive Corn

Continuous corn was ruled out in the analysis. According to the literature of the period few farmers grew corn on the same land from year to year. On all soils continuous corn would seriously deplete the organic matter, especially considering that crop residues were normally removed. It is probable that farmers periodically put their best corn land into meadow or small grains.

For crop group B for all five sample counties, a standard set of three crop rotations was initially considered, the first being CCCMM, a rotation mentioned in the Crawford County, Wisconsin soil survey as common on valley lands. Two other rotations considered possible for Group B were CCCGM and CG. The three rotations were taken as initial candidates for allocating available cropland, other than that needed for Group A (potatoes, vegetables and tobacco), among corn, small grains. and meadow.

As crop groups A and B involve the same capability classes (class I, subclasses IIe and IIw), their crop allocations were combined as shown for Clayton County, Iowa in the first row of table A-7. The 58,000 acres in these soils were estimated to have included the 2,300 acres in vegetables and 1,400 acres in potatoes, plus 29,310 acres in corn, 20,670 acres in small grains, and 4,320 acres of rotation meadow.

Group C--Two-crop Small Grain/Meadow Rotations

Crop group C lands represented situations where steep slopes or other limitations such as shallow soils generally prohibited the culture of any corn, even that in rotation with meadow, recalling the earlier conclusion that few effective supporting conservation practices were in place in 1930. In the literature examined, one rotation prominently mentioned for this case was GGMM. Another was GGM. These were selected as starting points for reconstructing probable 1930 rotations involving only small grains with meadow.

Cropland group C restricted to small grains and meadow included land use capability subclasses IVe and IIs, IIIs, and IVs (table 4, table A-7). It included 11,900 acres for Clayton County, our example, and 137,475 acres for the five sample counties combined. Allocating all these soils in Clayton County to a GGM rotation, which apparently was the most common rotation followed throughout the five sample counties, indicates that there were about 7,933 acres in small grains and 3,967 acres in meadow.

Group D--Three-crop Corn/Small Grain/Meadow Rotations

Crop group D allowed a wider array of possible crop combinations and crop sequences, which also varied among the five sample counties. Group D involved only cropland in capability subclass IIIe---about 149,100 acres for Clayton County and 289,225 acres for the five counties (table 4). The leading three-crop rotation was CGM, as one year of corn followed by a year in oats or other small grain, followed by one year of clover or other meadow crop, but with it having been seeded in with the small grain nurse crop.

The CGM rotation was mentioned as frequently followed in nearly every soil survey or erosion report researched. Further, it seems to have had wide use throughout the region, given that it was a primary rotation tested against fallow on research plots at the Conservation Experiment Stations at Clarinda, Iowa; Bethany, Missouri; and La Crosse, Wisconsin.

In reviewing the history of the Clarinda Station, Browning recalled that the farm purchased for the Station site had been under cultivation for more than 75 years, was tenant-operated, and was

generally in a run-down condition, with corn having been grown about 75 percent of the time, and with no sign of conservation practices that would help reduce soil and water losses (Browning,1948,p.12). In another report of the period Uhland indicated that for a three-year CGM rotation on Marshall silt loam soils at Clarinda, average annual runoff was only 31 percent that for continuous corn, and average annual soil losses were only 18 percent those for continuous corn (Uhland,1949,p.2).

The research farm at the La Crosse, Wisconsin Station had also been cultivated for about 75 years (Hays and others,1949,p.10). It too was unproductive and with no evident soil conserving practices. At Bethany, Missouri, an early analysis of erosion involved comparing continuous cropping to either corn, alfalfa, and blue grass against the 3-year rotation of CGM, so CGM was likely a very common rotation, or one considered by the researchers to be at least a minimal alternative to continuous cropping, or perhaps both (Smith and others,1945,p.53). Under continuous corn for 10 years on Shelby loam soils at Bethany, the measured soil loss averaged 50.9 tons/ac/yr. The measured loss for a CGM continued for 10 years was only 7.5 tons/ac/yr (Uhland,1949,p.2).

The CGM sequence was also a leading rotation studied for erosion control effects by Hays and Clark in another Wisconsin bulletin (1941). On these considerations several 3-crop rotations, all involving CGM, were first considered for each of the five counties in the erosion analysis for MLRA 105. The acreages assigned to each rotation in this group as in groups AB and C were adjusted where necessary to check with the crop acres officially reported in the 1930 Census of Agriculture. The shares of land in group D finally assigned to the various rotations are in parentheses:

Clayton County, Iowa: CGM (70%) and CCGM (30%)

Houston County, Minnesota: CGMM (20%), CCGM (30%), and CCGMM (50%)

Winona County, Minnesota: CGM (100%)

Crawford County, Wisconsin: CGM (100%)

Vernon County, Wisconsin: CGM (15%), CCGM (85%)

Comment on Rotation Meadow: The overall Census control acreages and the composition of meadow in each sample county in 1930 are in tables 4 and A-4. While the data on meadow involved five different types of vegetative cover (table A-4), the matching of cropland to the various crop rotations was only to the county totals for meadow. This implied that all meadow could be any grass or legume, or any mixture of the two.

Steps in Deriving USLE Erosion Rates for 1930

Carrying through the allocation procedures described to all five sample counties and arriving at USLE estimates of erosion losses on cultivated cropland involved five general steps. These could be followed in similar studies for other areas. The first four were critical in estimating the cover-management factor **C** with regard for crops grown, rotations possibly followed, and the tillage or residue management practices used.

Step 1-- Defining Crop and Rotation Groups: Match the soils in each county by land use capability class/subclass to cropping sequence groups. As indicated earlier the rotations having high values of **C** could be assumed more likely on the better soils, while rotations having lower **C** values were more likely to have been followed on soils having greater erosion hazards and more limitations for production.

We assumed that in the period 1925-35 the rotations involving minor row crops and intensive corn production (crop groups A and B) occurred mainly on the soils in land use capability subclasses I, IIe, and IIw. Group C sequences (two-crop small/grain/meadow rotations) were assigned mostly to capability subclasses IVe, IIs, IIIs, and IVs. Three-crop corn/small grain/meadow rotations (Group D) were assigned to the capability subclass IIIe lands.

Step 2--Estimating Available Cropland: Determine from modern soil surveys for Clayton and other sample counties (Kuehl,et.al.,1982) the total acres of each soil or land use capability class suitable and needed for the principal crops in each county.

Step 3--Estimating Principal Crops by Soils: Estimate the percent of each soil type or capability class devoted to the principal crops in 1930, and calculate corresponding acreages. Adjust the estimates as needed to balance the calculated acres to the acres of cropland reported in the 1930 Census of Agriculture. Completing steps 1, 2 and 3 produced the information in table 4.

Step 4--Matching Crops and Rotations to Soils: Estimate the percentage of each soil or capability class devoted to each crop rotation. Distribute accordingly the acres for each crop given in table 4. Adjust the rotation acres as needed to balance to the 1930 reported acres of each crop. Such adjustments could involve: (a) changes in the relative percent of the various rotations, or (b) alternative rotations.

Step 5--Other Factors and Calculations: To this point the acres in each combination of soils and rotations were determined and the USLE factors **K**, **L**, **S**, and **C** could be assigned to each rotation and cropping sequence. Values of the rainfall and runoff factor **R** for each county were taken from Agriculture Handbook No. 537.

Soil scientists provided values for **K**, **L**, and **S** from soils data. Values for **K**, **L**, and **S** depend on the characteristics of the soil map units which comprise each soil group.

Values for the cover-management factor **C** in the USLE, for the various crop rotations and management systems, were provided by agronomists. Appendix table A-6 is an abridged list of **C** values for cropping sequences applicable to this study for MLRA 105.

Supporting conservation practices such as contour farming and terraces were not in general use in 1930. Therefore, for the purposes of this study, the support practice factor **P** was assumed to have a constant value of 1.0. The final calculations are then--

(a) **R** x **K** x **LS** x **C** x **P** = average annual gross erosion rate, in tons per acre per year

(b) Average annual soil loss per acre x acres = total average annual soil loss in tons per acre for each combination of soils and rotations;

(c) The sum of soil losses for all the combinations in step (b) = average annual soil loss, in tons per year, for the total cropland acres in the county or other area concerned.

Steps 1 to 5 were repeated for each sample county. Consolidated results for the five sample counties are in table 5. A weighted average annual soil loss rate of 14.9 tons/ac/yr under 1930 conditions was thus determined for the five sample counties as a group. This was the rate compared with the average annual erosion rate of 5.5 tons/ac/yr expected under 1992 conditions for the same group of five counties as estimated in the 1992 National Resources Inventory.

Erosion in Sample Counties, 1930, 1982 and 1992

Some brief background may be helpful here. The physical significance of soil loss is determined by the extent to which soil productivity in source areas is impaired and the landscape damaged from gullies, as well as the fate of any soil removed--whether it may be redeposited downfield , or transported to become accumulated or suspended sediment in other areas, structures or water courses. The relationships involved have recently been examined by Beach (1994) in three Minnesota basins within MLRA 105.

The complex processes were described earlier by Trimble and Lund in their research in the Coon Creek Basin:

> "..... material eroded from upland slopes has three immediate routes: It can be deposited within the basin either as colluvium or as alluvium, or it can be transported directly out of the basin to provide immediate sediment yield. Material deposited as colluvium can later be dissected and then redeposited as colluvium or alluvium, or it can be moved out of the basin. Alluvium can be eroded from the channel or floodplain and then transported from the basin, or it too can be redeposited farther downstream as alluvium" (Trimble and Lund,1982,p.6).

The economic consequences have similar dimensions. They include the cost of lost production potential in source areas and the costs associated with unnecessarily cleaning ditches or replacing roads, bridges and other structures. These rather ordinary and traditional economic costs become mingled with broad ecological implications for economic institutions and the natural environment. Preserving the beauty of rural areas, maintaining water quality, and assuring adequate current farm income while assuring a productive agriculture for future generations are all laudable goals. They argue for evaluation and balance within an ecological framework.

Comparisons in this study of cropland soil erosion between 1930, 1982 and 1992 in MLRA 105, an area of about 18,860 square miles (12+ million acres) and involving the major parts of 28 counties in four States, were limited to 'gross' soil erosion or on site displacement. The physical or socioeconomic consequences in the two periods are not examined, although they are reflected qualitatively in the gross rates for the area in principal crops.

Also evaluated were productivity-decreasing or 'excess' rates of erosion. The excess rate is defined as the gross rate of detachment in source areas, in tons per acre per year, less the rate 'T' at which losses could occur without impairing long term productivity and without applying additional fertilizers or other soil additives.

Information on cropland areas and acres of principal crops planted in 1930 and 1992 were available from the Census of Agriculture, supplemented where necessary from historical files in State statistical offices. Similar though not completely parallel information on cropland uses for 1992 is provided in the 1992 National Resources Inventory (NRI). The NRI estimates are derived from a point sampling procedure. Erosion rate estimates along with their estimated sampling error margins were provided for this study by the Natural Resources Inventory Division of the NRCS.

There are also margins for errors in Census data. These vary with the item being reported and the area covered. If obtained by a sampling procedure the Census estimate carries a sampling error plus a nonrespondent error. If the item is considered 'full-count' or required of all farms, it carries a nonrespondent but no sampling error. All the cropland and crop data accessed from the Census for this analysis are full-count items. The 1992 and other recent Census reports contain this information for most reporting items and counties. By special arrangements Census staff have provided relative errors for estimates made in 1974 of the broad item 'total harvested cropland' for each of the 28 counties in MLRA 105. On their recommendation, relative errors for 1974 are used in lieu of nonavailable similarly derived estimates of error in the 1930 data on total harvested cropland.

Silt deposition upon original flood plain soil, Vernon, Wisconsin. NRCS/USDA photo (Wisconsin 1-61).

It would also be possible to calculate gross erosion in 1992 using NRI as well as Census estimates of cropland acreages. The NRI and Census acreages differ considerably for pasture, woodland and other noncrop uses (table A-10). For cropland in general (item C) the two sets of estimates are fairly comparable if all counties in MLRA 105 are combined. For the area actually in principal crops as the primary concern in our analysis, the NRI estimate for the five sample counties, plus or minus its margin of error, brackets the Census figure. But because the NRI and Census estimates for the area in principal crops differ rather widely for the region and the Census data have smaller relative errors, the Census area estimates were used in computing gross erosion for the sample counties and the region.

Cropland Erosion Rates

Applying the crop allocation and USLE procedures described earlier, erosion rates on cropland in 1930 were developed by three crop groups for each of the five sampled counties and then combined as weighted averages for each cropland/crop group in the entire sample. Reviewing

briefly, the areas in cropland/crop group AB were allocated first to subsistence or minor cash row crops like potatoes, vegetables and any tobacco. The remaining AB land was considered available for relatively frequent corn in association with some small grains and rotation meadow. Crop group AB includes land use capability class I, and subclasses IIe and IIw. The group included about 220.6 thousand acres or 34 percent of the cropland used for principal crops in 1930. The top section of table 4 shows the percentage of each land use capability subclass suitable for crops in each sample county. The controlling or officially reported crop acreages for 1930 are listed in the bottom section.

Crop group C includes lands in capability subclasses IIs, IIIs, IVs and IVe. In 1930 group C accounted for about 137.5 thousand acres or 21 percent of the area in principal crops (table 4). This group was generally restricted to small grains and meadow. Group D includes all subclass IIIe land. It involved 289.2 thousand acres or 45 percent of the 647.3 thousand acres used for principal crops in the five sample counties in 1930. These is the area where most of the corn was likely grown, in various combinations with small grains and meadow.

The detailed assignments for 1930 of crops and rotations among the land use capability and crop groups of table 4 are illustrated for one county (Clayton County, Iowa) in table A-7.

Sample County Results

Besides Clayton County the sample counties included Houston and Winona Counties in Minnesota, and Crawford and Vernon Counties in Wisconsin. Expected average annual USLE soil erosion rates under 1930 conditions were computed for each designated soil or soil complex (soil map unit) classified as to land use capability in each of the five sample counties, considering further the crop sequences and rotations fitted to each mapping unit. Sets of USLE calculations were made for 437 map units, ranging from 81 map units for Winona County, Minnesota to 102 map units for Vernon County, Wisconsin (table 5).

For the five sample counties, the complete process required 1,590 USLE computations of erosion rates per acre and gross erosion (rate times acres), a pair for each considered rotation within each map unit within each land use capability subclass within each of the three crop groups AB, C and D, for each sample county. The number of USLE computations required varied from 254 for Houston County, Minnesota to 409 for Vernon County, Wisconsin.

Weighted average USLE soil loss rates for 1930 were then obtained for the various land use capability subclasses and crop groups. The erosion rates per soil mapping unit were estimated as the simple average of the USLE rates for each of 1 to 7 rotations considered relevant to the various (437) map units.

The results of this process were then pooled for the five sample counties (table 5). Expected annual erosion rates under 1930 conditions were generally highest for crop groups C and D. The estimated USLE erosion rates for 1930 were greatest for the capability subclasses where susceptibility to erosion was the main limitation (IIe, IIIe, and IVe), regardless of whether these areas were used for row crops or small grain rotations with meadow.

Under the distributions of various soils and crops grown in 1930, the average erosion rate on cropland in principal crops ranged from 9.1 tons/ac/yr in Winona County, Minnesota to 22.4 tons/ac/yr in Crawford County, Wisconsin. The estimated mean across all soils and crops in the five sample counties was 14.9 tons/ac/yr. The standard error of the mean for the 437-member series of USLE rates for each differentiated soil map unit in the area in 1930 was about 0.5 ton/ac/yr, for a relative error of 3.5 percent (table 5).

Table 6 compares cropping patterns and erosion conditions between 1930 and 1992 in the five sample counties. Erosion rates in 1930 ranged from 8.5 tons/ac/yr on the best soils used for row crops (crop group AB) to 18.4 tons/ac/yr on crop group C, as the vulnerable soils generally restricted to small grains or meadow. Rates were nearly as high (18.2 tons/ac/yr) for crop group D, as the capability class IIIe land used for various corn/small-grain/meadow rotations. Group D accounted for about 54 percent of the gross soil loss in the five counties but for 45 percent of all land in row crops, small grains or meadow. This appears to be the case even though a substantially lower share (36 percent) of cropland group D land was devoted to row crops than was the land in cropland group AB (56 percent). Rates of soil loss under 1982 and 1992 conditions across all row crops, small grains and rotation meadow for the sample counties were accessed from the National Resources Inventory. The NRI estimates for 1982 and 1992 are based on USLE factor values for 1,945 NRI sample points in the five counties, or for 16.1 percent of the 12,057 sample points for all of the 28 counties predominantly in MLRA 105.[10] For example, for 1992 the estimated overall rate for the principal crops was 5.5 tons/ac/yr. This was about 63 percent less than the 14.9 tons/ac/yr for 1930 (table 6).

Between 1930 and 1992 the area in meadow in the five sample counties rose by 68 percent, increasing to 33 from 23 percent of the land in principal crop uses. The large reduction in the

---

[10] Interestingly, the 1930 Census of Agriculture indicates that 647 thousand acres (also 16.4 percent) of the 3.9 million acres of the land in principal crops in the region, for which USLE erosion rates were reconstructed, were in the five sample counties. The percentage for 1992 was virtually the same--at 16.5 percent. This indicates not only that the five sample counties were and are quite representative of all 28 counties in the region but also that the net result of land use shifts since 1930 has been to make the land use pattern of the region relatively homogeneous.

erosion rate between 1930 and 1992 occurred despite large absolute and relative increases in row crops (216 thousand acres or 91 percent). The gain in row crops was achieved by expanding (by 14 percent) the total area suitable for all crops, by greatly reducing (by 80 percent) the area in oats and other small grains, and by applying recommended soil conservation measures.

Table 7 sums up the sample county analysis for 1930 and 1992. The respective erosion rates applied to the total areas in principal crops indicate that gross erosion in the five-county sample was reduced by between 45 and 67 percent between 1930 and 1992. The mid-value or 'average' reduction would be 57 percent. Expressing the reduction as a range emphasizes that such estimates are subject to error. Interval rather than single-valued estimates also give policymakers a better basis for evaluating the effectiveness of conservation programs and for justifying the additional measures needed to bring erosion losses down to acceptable levels.

Erosion in MLRA 105, 1930, 1982 and 1992

Extending the results from the sample county analysis to all of MLRA 105 was the final step in the procedure. The complete land use and crop production profiles developed earlier from the Census of Agriculture and other sources simplified the regional analysis, as the land use patterns and the acres in each principal crop in 1930 and 1992 were then known quite accurately, for the region as well as the counties sampled. The four sets of information needed for comparing cropland erosion for the region in 1930 and 1992 were: (1) Crop uses in 1992; (2) crop uses in 1930; (3) erosion rates per acre in 1992; and (4) the erosion rates per acre for the region in 1930. Set (4) was the 'unknown' to be determined, from available data on cropland use and the erosion rates estimated for the sample counties in 1930.

Regional Cropland Uses

The proportions of cropland used for row crops, small grains and rotation meadow in 1992 and in 1930 were nearly the same for the 28 counties in MLRA 105 combined as for the five sample counties (figure 4). Details are in table 6 for the sample counties and in table A-8 for the region. In the region row crops went from 31 percent of the area in the main crops in 1930 to 61 percent in 1992. The proportion in small grains went from 41 percent down to 6 percent.

Table 5. Soil loss rates by crop groups and land use capability subclasses, sample counties, 1930

Crop groups and LCC[1]	Share of total crop land	Clayton County Iowa	Houston County Minnesota	Winona County Minnesota	Crawford County Wisconsin	Vernon County Wisconsin	Average for five counties
	Percent	Estimated soil loss rate in 1930, tons/ac/yr					
Group AB	34.1	8.2	9.4	7.7	8.0	9.9	8.5
Class I	3.3	3.0	3.0	3.6	3.6	3.4	3.3
Sc IIe	24.8	11.0	11.4	8.4	10.5	11.9	10.0
Sc IIw	6.0	6.2	3.4	2.8	4.6	2.9	4.7
Group C	21.4	9.1	21.4	19.1	22.0	16.1	18.5
Sc IVe	19.6	14.8	22.5	22.5	23.1	16.2	20.1
Sc IIs	0.7	0.7	1.0	0.9	1.0	0.8	0.8
SC IIIs	0.4	0.7	1.5	0.9	1.1	0.5	0.9
SC IVs	0.7	2.6	1.6	1.4	2.1	0.8	2.2
Group D	44.5	20.1	15.3	7.8	30.8	19.9	18.2
SC IIIe	44.5	20.1	15.3	7.8	30.8	19.9	18.2
Totals or averages	100.0[1]	16.3	13.9	9.1	22.4	15.9	14.9
Pct. Error[2]	--	8.3%	8.5%	8.4%	7.0%	5.8%	3.5%
Map symbols[3]	--	84	74	81	96	102	437

1. First column adds to 100 per cent. Total area for all groups, crops and land use capability classes: 647,300 acres.
2. Standard error of estimate as percent of the estimated mean soil loss rate for the county.
3. Number of different soils or soil complexes on modern soil maps for which erosion rates were estimated from the USLE. Where multiple rotations were considered for a given map symbol, the mean of their USLE rates was assigned to the symbol involved.

Table 6. Principal cropland uses and soil erosion in 1930 and 1992 in five sample counties in MLRA 105*

Cropland and groups	Share of crop acres	Cropland in group	Soil loss rate per acre[4]	Gross soil loss per year	Distribution of crops by groups		
					Row crops	Small grains	Meadow
	Percent	1,000 ac	Tons/ac/yr	1,000 tons	1,000 ac	1,000 ac	1,000 ac
Principal Crops, 1930 total	100	647	14.9	9,654	238	259	150
			(Percent)	(100)	(37)	(40)	(23)
AB: Minor row crops/intensive corn[1]	34	220	8.5	1,871	125	76	19
			(Percent)	(20)	(56)	(35)	(9)
C: Small grains/meadow[2]	21	138	18.4	2,534	9	80	49
			(Percent)	(26)	(7)	(36)	(57)
D: Corn/small grains/meadow[3]	45	289	18.2	5,249	104	103	82
			(Percent)	(54)	(36)	(36)	(28)
Principal Crops, 1992 total	100	756	5.5	4,172	454	51	251
			(Percent)	100	(61)	(6)	(33)
Increase or decrease, 1930-1992	--	109	9.4	5,482	216	-209	102
	(Pct. change)	(14)	(63)	(57)	(91)	(-80)	(68)

* Sample counties: Clayton County, Iowa; Houston and Winona Counties, Minnesota; Crawford and Vernon Counties, Wisconsin.

[1] Group AB includes potatoes, vegetables or tobacco rotated with corn or small grains, with the remaining land devoted to frequent corn, with some small grains or meadow. Group AB includes areas in land use capability Class I and subclasses IIe and IIw.

[2] Group C generally restricted to small grain and meadow cropping. Group C includes areas in land use capability subclasses IIs, IIIs, IVs and IVe.

[3] Group D includes rotations including corn, small grains and meadow, all on capability subclass IIIe land.

[4] Soil loss rates for 1930 evaluated by crops grown on the land use capability classes indicated. Soil loss rate for 1992 is for all crop groups combined, from USDA's 1992 National Resources Inventory.

Table 7. Cropland erosion in 1930 and 1992 for five sample counties in MLRA 105

Items	Item	Units	1930	1992	Percent change, 1930-1992
1. Principal crops (Census)	Estimate	1,000 ac	647.0	756.1	17
	(Error)	(1,000 ac)	(13.5)	(18.1)	--
2. USLE erosion rate (NRI)	Estimate	Tons/ac/yr	14.9	5.5	-63
	(Error)	Tons/ac/yr	(1.0)	(0.8)	--
3. Gross erosion, average/yr	Estimate	1,000 tons	9,654	4,172	-57
	(Error)	(1,000 tons)	(848)	(704)	--
4. Lower limit, erosion/yr	Estimate	1,000 tons	8,806	3,468	* -45
Upper limit, erosion/yr	Estimate	1,000 tons	10,502	4,876	** -67

Sample counties: Clayton (Iowa), Houston and Winona (Minnesota), Crawford and Vernon (Wisconsin).
Item Explanations:

Item 1. Area estimates from the 1930 and 1992 Censuses of Agriculture. For Census acres, margins of error in constructing the 95-percent confidence interval refer to nonrespondent error for all cropland harvested, a full- count item. All error margins refer to the 95-percent confidence interval.

Item 2. Erosion rates derived from the Universal Soil Loss Equation (USLE). For 1930 the rates are reconstructed from factors for rainfall, soil erodibility, field slope and length, cropping patterns, tillage practices, and residue management practices for 437 different soils or soil complexes in five sample counties. Error margins for erosion rates per acre in 1930 based on the standard error of this 437-member series of estimated USLE erosion rates. USLE erosion rates for 1992, with their margins of error for constructing 95-percent confidence intervals, from USDA's 1992 National Resources Inventory.

Item 3. Average gross erosion per year estimated as the mid-value of the lower and upper limits in item 4. This may not be the same as the simple product of items 1 and 2.

Item 4. The lower limit of the 95-percent confidence interval for gross erosion per year is the product of [crop acres less its margin of error] times [the erosion rate less its margin of error]. The upper limit is the product of [crop acres plus its margin of error] times [the erosion rate plus its margin of error].

* The single asterisk identifies, at a 95-percent confidence level, the minimum percentage reduction in gross erosion between 1930 and 1992. It is obtained by subtracting 100 from the upper limit for 1992 taken as a percentage of the lower limit of estimated erosion in 1930.

** Identifies the maximum percentage reduction in gross erosion between 1930 and 1992. It is obtained by subtracting 100 from the lower limit for 1992 as a percentage of the upper limit of erosion in 1930.

The share for meadow, which had become mostly alfalfa by 1992, rose from 28 percent of all land in principal crops in 1930 to 33 percent in1992. Between 1930 and 1992 the total area in row crops had increased by 91 percent in the sample counties. The increase for the entire region was 131 percent. This indicates that the use of land for corn and soybeans has intensified more in the 23 counties not sampled than in the five counties sampled. It also implies that between 1930 and 1992 the rate of erosion on cropland was reduced less in the nonsampled than in the five sampled counties. This was the case.

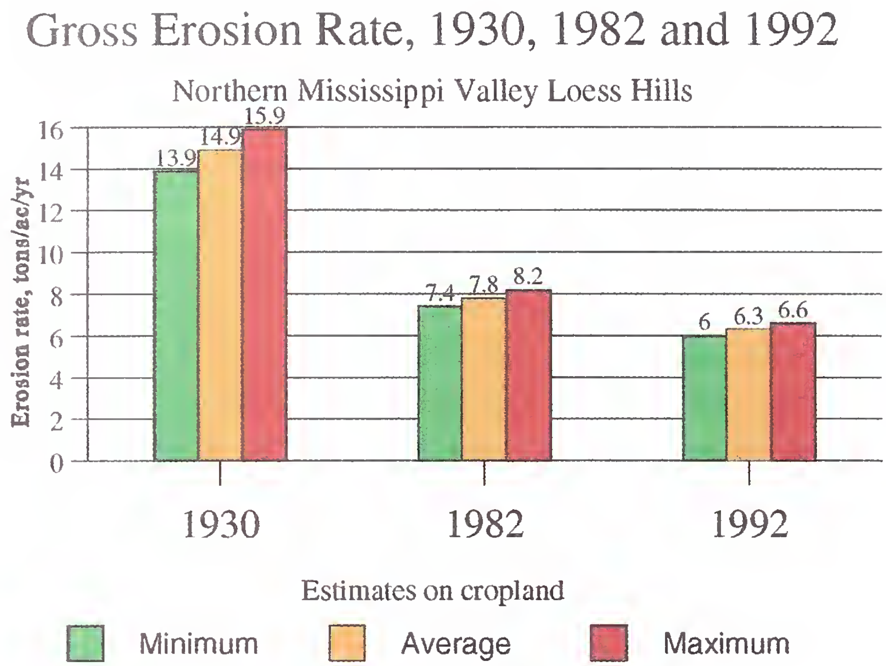
To explain, it is reasonable to assume that the average 1930 erosion rate for the sample counties (14.9 tons/ac/yr) was a good approximation of the 1930 rate for the nonsampled counties, as the typography, soil types, rainfall, and general land uses patterns were similar in the two areas. According to the National Resources Inventory (NRI) the average USLE rate for 1992 in the nonsampled counties was about 6.7 tons/ac/yr versus the 5.5 tons/ac/yr for the sampled counties. Between 1930 and 1992 the rate of soil loss for cropland was reduced by 55 percent in the 23 counties not sampled but by 63 percent in the five counties sampled.

The area in rotation meadow in the region increased by about 36 percent between 1930 and 1992. Nearly 33 percent of the cropland in the region as well as in the five sample counties is in alfalfa each year. Because alfalfa is normally left in for a longer period than other legumes, this implies that, where practiced, crop rotations now involve at least several years of meadow. The most common rotation in 1930 was corn for a year, followed by a year in oats or other small grains, then followed by only one or two years of hay meadow, usually clover or a clover/timothy mix.

Approximating Regional Erosion in 1930

Extrapolating to a regional level the cropland erosion rates for 1930 for the five sample counties first considered that any erosion rates computed from the USLE were themselves sample estimates of the erosion rates occurring in 1930 across all 28 counties mostly within MLRA 105. In this case all of MLRA 105 and minor sections in contiguous MLRA's were viewed as the'population' for which erosion in 1930 was to be estimated from information about the sample. Although the five sample counties were not randomly chosen in a strict sense, they were an unbiased selection. All of the 28 counties in the region were presumed to have had an equal chance of having a soil or erosion survey reports completed during the decade 1925-1935. The availability of a soil survey report for this period was the main criterion for choosing which counties to sample.The status of soil surveys for all 28 counties principally in the region is shown in figure 1.

Figure 5



In each of the sample counties USLE erosion rates were computed at the level of each relevant rotation within each soil map unit, with each mapping unit in turn identified as to land use capability class and subclass. The rotations and crops were distributed accordingly. A total of 437 differentiated map units grouped into the eight capability classes, were required in deriving a weighted average USLE soil loss rate 'A' in tons/ac/yr as of 1930 for each sample county and then for the five counties combined (table 5).[11] This value for 'A', 14.9 tons/ac/yr, is an 'estimate' for the Northern Mississippi Valley Loess Hills of the average annual erosion rate occurring under 1930 conditions.

[11] Note in tables 7 and 8 that for 1992 the mean estimates and error margins differ between the sample counties and the MLRA 105 region. This is because the analysis for 1930 was confined to five counties representing the entire region, whereas for 1982 and 1992 it was possible to rely on the National Resources Inventory estimates of USLE erosion rates and their respective margins for error. These were separately available for the five sample counties, the 23 nonsampled counties and then for all 28 counties predominantly in the region.

Results of the analysis of erosion conditions in 1992 versus 1930 for the Northern Mississippi Valley Loess Hills are given for the five sample counties in table 7 and then for all 28 counties in the region in table 8, which also includes comparable data for 1982. For 1930 the mean estimate for the sample counties for the gross USLE rate of erosion per acre (14.9 tons/ac/yr), as well as the margin of error in this rate (1.0 ton/ac/yr), were considered to be estimates for the region as well as for the sample counties.

Some overall results of the comparison of erosion conditions for the Northern Mississippi Valley Loess Hills in 1982 and 1992 versus 1930 are graphed in figures 5, 6 and 7. Gross USLE erosion rates per acre are compared in figure 5. The center bar denotes the mean estimated rate, while the minimum and maximum bars denote the lower and upper limits, respectively, of the 95-percent confidence interval for the estimated erosion rate.[12]

The gross quantities of erosion and quantities exceeding **T** are shown in figure 6. Figure 7 shows the minimum, average, and maximum estimates of the gross quantities of erosion occurring on cropland. These estimates are also for the 95-percent confidence interval.

Figure 8 compares selected items between 1930 and 1992 for the sample counties and the entire region in terms of their amounts in 1992 relative to 1930.

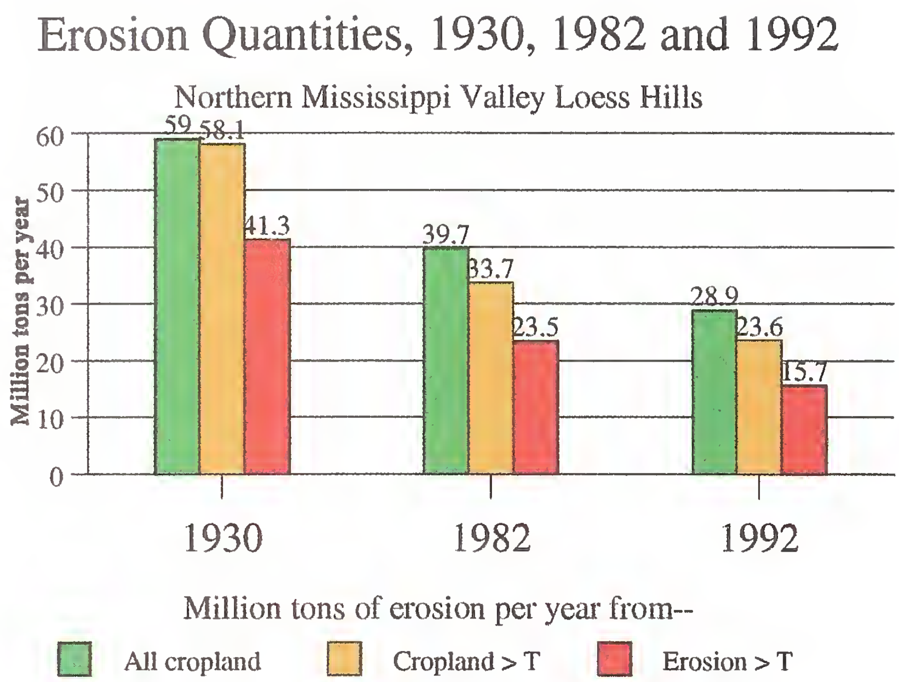
Summing up the essential results: Under conditions in 1992 the average annual erosion rate per acre of the land in principal crops in the Northern Mississippi Valley Loess Hills (MLRA 105) was only 42 percent of the rate estimated for 1930, and the total amount of soil being displaced on cropland in 1992 was only 49 percent of the amount displaced in 1930. These reductions were achieved despite the area used for row crops, small grains or rotation meadow in 1992 being 16 percent greater than in 1930, while the area in row crops alone was 2.3 times the area in row cropsin 1930. The chart also indicates that between 1930 and 1992 the area in row crops in the 23 counties not sampled had expanded more than in the five counties sampled.

The respective per-acre erosion rates for 1930, 1982 and 1992 are multiplied by the acreages in principal crops for the entire region (table 8). Between 1930 and 1992 there was a drop of 58 percent in the erosion rate, from 14.9 tons/ac/yr down to 6.3 tons/ac/yr. At a 95-percent level of confidence, it can be stated that reducing the gross erosion rate to 6.3 tons/ac/yr in 1992 translated into a reduction between 1930 and 1992 of between 42 and 58 percent in the amount of gross erosion

---

[12] The error margins given are for the 95-percent confidence interval. Divide the margins of error by 1.96 to obtain standard errors of the estimated mean erosion rates and total quantities for the years 1930, 1982 and 1992.

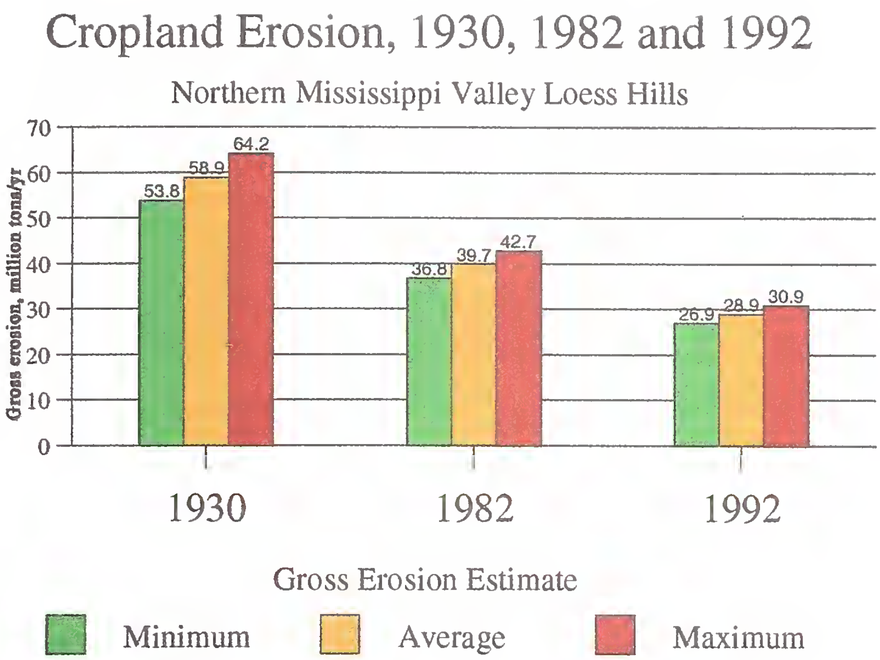
Figure 6



occurring on the land used for principal crops, for an average or mid-value reduction of 51 percent. Expressing the changes in terms of confidence intervals allows for errors inherent in the estimates of crop acreages as well as in erosion rates per acre. Between 1930 and 1992 the 'average' reduction in gross erosion per acre was 58 percent. Gross erosion had been reduced by about 33 percent between 1930 and 1982. By 1992 the gross erosion occurring in 1982 had been further reduced, by about 27 percent.

In 1930 between 54 and 64 million tons of soil per year were being displaced by erosion (figure 7 and table 8). By 1992 this had been reduced to between 27 and 31 million tons per year. The mid-value or 'average' displacement was slightly under 29 million tons in 1992 compared to nearly 59 million tons per year in 1930. Note that the mid-value is the simple average of the computed lower and upper limits of the 95-percent confidence interval. Its margin of error is half the difference between the upper and lower estimate limits.

Figure 7

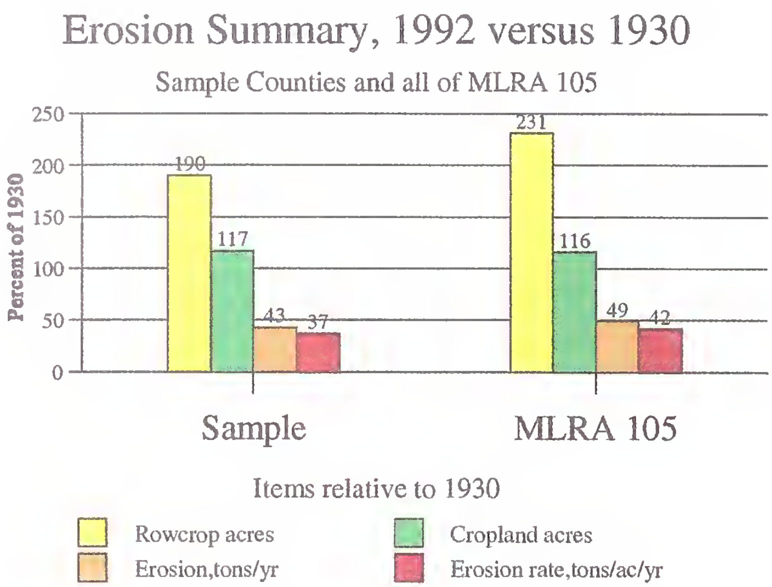


Productivity-Decreasing Erosion

The erosion analysis for MLRA 105 also examined the extent to which erosion in the three periods 1930, 1982 and 1992 could be considered to adversely affect long-term soil productivity. While any erosion is generally undesirable and regarded as 'excessive', excess erosion from a productivity standpoint was evaluated in this study as the amount by which gross erosion rates per acre exceeded allowable tolerances. The 'excess' rate of erosion was defined as the gross rate of displacement less the rate that can occur without an appreciable loss in soil productivity, and without applying substitute nutrients or other soil additives. For the five sample counties predominantly in MLRA 105, this tolerance or 'T' value varied between 3 and 5 tons/ac/yr, according to particular soils.

Estimates for excess erosion in 1982 and 1992 were accessed from the National Resources Inventory (NRI). For 1930 the estimates were obtained by first examining gross soil displacement for each of the 437 soil mapping units found in the five sample counties, then converting these to gross rates of displacement per acre, and then subtracting the appropriate T-values per acre as recorded in current soil surveys or field technical guides. Any positive balances per acre were multiplied by the acres in each mapping designation, and then aggregated by land use capability

Figure 8



subclasses within each cropland/crop group for each sample county, thus obtaining overall rates per acre of erosion in excess of assigned T values.

The results of the analysis of erosion rates and volumes greater than **T** for 1930 are given in table 9 for each of the eight land use capability subclasses and the three major cropland/crop groups defined for each sample county. The rates greater than **T** are averaged across all subclasses and crop groups in the counties but across only the cropland that was eroding at gross rates greater than **T** in 1930. The overall rate in excess of **T** in 1930 for the five sample counties (11.9 tons/ac/yr) and its corresponding gross USLE rate per acre for the individual areas eroding at rates greater than **T** (16.7 tons/ac/yr) were extrapolated to the region in calculating total amounts of gross as well as productivity-decreasing erosion.

By 1992 the <u>cropland area</u> eroding at rates greater than **T** and losing productivity in 1930 had been reduced by nearly 50 percent (table 10). The improvement between 1930 and 1982 was about 34 percent, with a further gain of 22 percent between 1982 and 1992.

By 1992 the <u>total amount</u> of erosion on the cropland eroding at a rate in excess of **T** in 1930 had been reduced by 59 percent, and by 30 percent less than in 1982. The yearly soil losses that can be associated with declining soil productivity in MLRA 105 amounted to over 41 million tons in 1930, 23.5 million tons in 1982, and 15.7 million tons in 1992, which was about 62 percent less than in 1930. These gains have additional significance when considering that the assigned **T**values were

less than 5 tons/ac/yr for about 36 percent of the lands in MLRA 105 that were eroding at rates greater than 'T' in 1992. A T-value of 5 tons/ac/yr is frequently cited as the tolerance appropriate for most loessial soils in the Midwest.[13]

Soil displacement expressed in inches of surface soil removed per year or over extended periods was the measure commonly employed in early studies of erosion processes. In some respects it is easier to visualize than the weight displaced. At the risk of appearing overly precise an illustration can be given. Using a weight of 142 tons per acre-inch of soil as an approximate conversion constant (Uhlman,1949,p.2), total erosion per acre (16.7 tons/ac/yr) on the cropland eroding in excess of **T** in 1930 was equivalent to 0.12 inches (3 mm) per year. The excess or productivity-decreasing erosion rate in 1930 (11.9 tons/ac/yr) would amount to 0.08 inches (2.1 mm) per year. By 1992 total soil displacement had been reduced to 13.4 tons/ac/yr, equivalent to 0.09 in/yr (2.4 mm/yr). The portion associated with the gradual loss of productivity (8.9 tons/ac/yr) was equivalent 0.06 in/yr (1.6 mm/yr).

The increments of soil removed in a given year may be hardly if at all noticeable but they assume major importance if continued. A gross erosion rate of 16.7 tons/ac/yr (0.111 in/yr) continued over 25 years amounts to nearly 3 inches of topsoil displaced, or to nearly 6 inches if continued for 50 years. An average gross rate in 1930 in Crawford County, Wisconsin, one of the sample counties, on vulnerable capability subclass IIIe land containing various soil series and used for corn in a three-year rotation with small grains (CCG), was estimated at 30.7 tons/ac/yr (0.2 in/yr), equivalent to 5.4 inches of topsoil removed over a 25-year period, and to nearly 11 inches over a 50-year period.

Figure 6 relates three measures of aggregate annual erosion on cropland in 1930, 1982, and 1992: (1) Gross erosion occurring on all cropland: (2) gross erosion occurring on the cropland eroding at rates greater than T; and (3) the amount of this excess erosion occurring on the area included in (2). Between 1930 and 1992 all erosion on all cropland fell by 51 percent, or from 59

---

[13] In discussing the present work at a June 1995 Symposium on 20th Century Farm Policies, Pierre Crosson of Resources for the Future, Inc. suggested that the T-value concept may not be a reliable basis on which to associate productivity declines with gross erosion rates. Even on relatively deep loessial soils farmers have substituted fertilizers, etc. to compensate for fertility losses in upper soil horizons, and have shifted to reduced tillage to minimize current erosion and help restore previous losses of organic matter. In essence the concept was more relevant to conditions in the area in the 1930s than presently, and also presently if topsoils are shallow. The loess mantle in the Northern Mississippi Valley Loess Hills (MLRA 105), for example, is relatively thin compared to, say, that of the Iowa and Missouri Deep Loess Hills (MLRA 107).

to about 29 million tons per year. That on the cropland that had been eroding at rates greater than T in 1930 fell by 40 percent. The tons of erosion causing productivity to decline was reduced by 62 percent between 1930 and 1992, or from about 41 down to 16 million tons per year.

The essential results of this study have been illustrated in figure 8: Under conditions in 1992 the average annual erosion rate per acre of the land in principal crops in the Northern Mississippi Valley Loess Hills (MLRA 105) was only 42 percent of the rate we estimated for 1930, and the total amount of soil being displaced on cropland in 1992 was only 49 percent of the amount displaced in 1930. These reductions were achieved despite the area used for row crops, small grains or rotation meadow in 1992 being 16 percent greater than in 1930, while the area in row crops alone was 2.3 times the area in row crops in 1930.

Conservation in MLRA 105

The reductions summarized in figure 8 occurred despite the area in corn or other row crops in 1992 being about 2.3 times what it was in 1930. It appears that private and public conservation efforts have had definitely reduced soil erosion in MLRA 105 because, with other factors considered equal, erosion losses increase with the area devoted to row crop production, as opposed to small grains or hay crops.

Onfarm Conservation Practices

Data for on-farm conservation efforts in the Northern Mississippi Valley Loess Hills region for the period 1980 to 1994 are graphed in figure 9. Some details on conservation practices from the NRI's for 1982, 1987, and 1992 are in table 11. The significant reductions in erosion were not accomplished by using land resources less intensively, as by leaving land in small grains or permanent hay meadow instead of growing more row crops. They were the result of less intensive tillage and a more intensive application of capital to land, represented by the cost of installing on-farm conservation measures and investing in watershed protection and development projects.

According to the 1992 NRI, stripcropping and/or terraces were in place on 1.3 million acres of cropland, of which 130 thousand acres were terraced (figure 7). Terracing has increased about 2 percent annually since 1982 and stripcropping at a slightly lower rate. Also, while reduced tillage can require substantial capital investments in specialized new equipment like no-till planters and involve higher herbicide costs, its soil and water conservation benefits are also substantial.

Table 8. Cropland erosion in 1930, 1982 and 1992 in 28 counties predominantly in the Northern Mississippi Valley Loess Hills (MLRA 105)

Items	Units	1930	1982	1992	Percent changes		
					1930-82	1930-92	1982-92
1. Principal crops	1,000 ac	3,952	5,090	4,583	29	16	-10
(Error margin)	1,000 ac	(83.4)	(107)	(105)	--	--	--
2. USLE erosion rate/yr	Tons/ac	14.9	7.8	6.3	-48	-58	-19
(Error margin)	Tons/ac	(1.0)	(0.4)	(0.3)	--	--	--
3. Gross erosion per yr	1,000 tons	58,967	39,749	28,904	-33	-51	-27
(Error margin)	1,000 tons	(5,194)	(2,949)	(2,036)	--	--	--
4. Lower limit, erosion/yr	1,000 tons	53,773	36,800	26,868	* -22	*-42	* -16
Upper limit, erosion/yr	1,000 tons	64,162	42,697	30,940	** -42	** -58	** -37

<u>Item Explanations:</u>

<u>Item 1</u>. Area estimates from the 1930 and 1992 Censuses of Agriculture. For Census acres, margins of error in constructing the 95-percent confidence interval refer to nonrespondent error for all cropland harvested, a full-count item. Owing to ambiguities in the published relative standard errors for harvested cropland in 1982, the Census Bureau suggested using for 1982 the more accurate relative errors as published for 1992. All error margins in the table refer to the 95-percent confidence interval.

<u>Item 2</u>. Erosion rates derived from the Universal Soil Loss Equation (USLE). For 1930 the rates are developed from factors for rainfall, soil erodibility, field slope and length, cropping patterns, tillage practices, and residue management practices for 437 soils or soil complexes in five sample counties. Error margins for erosion rates per acre in 1930 based on the standard error of this 437-member series of estimated USLE erosion rates. USLE erosion rates for 1982 and 1992, with their margins of error for constructing 95-percent confidence intervals, from USDA's 1992 National Resources Inventory.

<u>Item 3</u>. Average gross erosion per year estimated as the mid-value of the lower and upper limits in item 4. This may not be the same as the simple product of items 1 and 2.

<u>Item 4</u>. The lower limit of the 95-percent confidence interval for gross erosion per year is the product of [crop acres less its margin of error] <u>times</u> [the erosion rate less its margin of error]. The upper limit is the product of [crop acres plus its margin of error] <u>times</u> [the erosion rate plus its margin of error].

* The single asterisks identify, at a 95-percent confidence level, the minimum percentage reductions in estimated gross erosion between 1930 and 1982, then between 1930 and 1992, and then between 1982 and 1992. They are obtained by subtracting 100 from the upper limit for 1992 taken as a percentage of the lower limit of estimated erosion for 1930, or for 1982 if the comparison is between 1982 and 1992.

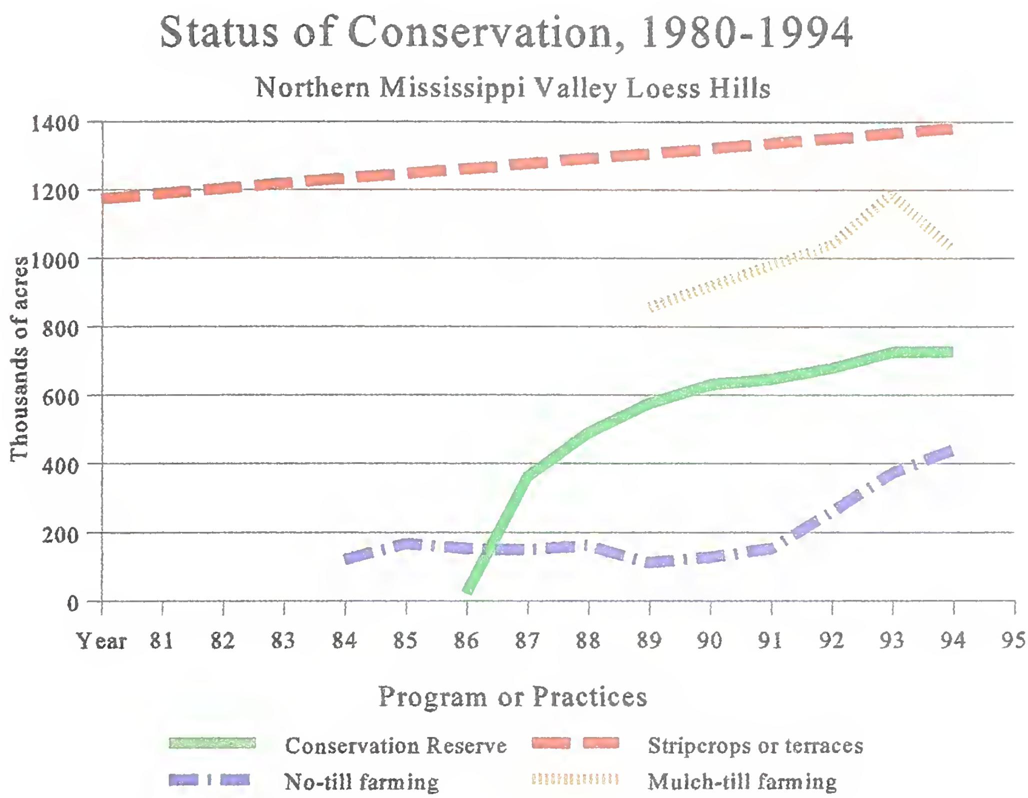
** The double asterisks identify, at a 95-percent confidence level, the maximum percentage reduction in estimated gross erosion between 1930 and 1982, then between 1930 and 1992, and then between 1982 and 1992. They are obtained by subtracting 100 from the lower limit for 1992 taken as a percentage of the upper limit of estimated erosion for 1930, or for 1982 if the comparison is between 1982 and 1992.

Buffer strips of permanent brome grass with continuous corn is now a common conservation practice; northeast of Elkader, Iowa. Photo by Douglas Helms, NRCS/USDA. August 1995.

The observed trend for contour stripcropping and terracing is sketched in connecting the three available estimates from the National Resources Inventory---for 1982, 1987 and 1992 (table 11). Thre three estimates lie on a nearly straight line. In 1992 these measures were in place on 1.3 million acres of cropland, of which 130 thousand acres were terraced. According to the NRI, terracing has increased about 2 percent annually since 1982 and stripcropping at a lower rate.

While reflecting an overall intensity of conservation activity, the acreages in table 11 for conservation measures on cropland, grazing and woodlands include some double counting, as up to three practices could have been recorded for an NRI sample point or its immediate vicinity. According to Consolidated Federal Funds Report (CFFR) data obtained from the Bureau of the Census, Federal cost shares paid under the Agricultural Conservation Program (ACP) in the five sample counties ranged around $120,000 per county per year over the period 1983-1992 (USDC,1994c). The CFFR figure is adjusted to1992 price levels. The average for all 28 counties in MLRA 105 was $123,000 per county per year, indicating that the level of participation in the ACP was somewhat lower in the five counties sampled than in the 23 counties not sampled.Other related research indicates that, including installation and maintenance costs, farmers in Iowa, Minnesota

Figure 9



and Wisconsin pay an average of 52 percent of the total cost of onfarm conservation practices. State and local agencies cover 8 percent, for a nonfederal total of 60 percent and a Federal share of 40 percent (Pavelis,1985,p.22). Federal shares divided by 0.40 give an estimate of the total investment in onfarm conservation practices made in MLRA 105 in the ten years 1983-92. The total in 1992 dollars comes to $86.1 million for the ten years, of which $44.8 million was paid by farmers, and about $41.3 million by Federal,State and local agencies.

Conservation Tillage

Some time plots for conservation tillage are shown in figure 9. Conservation tillage is gaining rapidly in the sample counties and the general region.[14] Residues from high-yielding corn

---

[14] Data on conservation tillage in figure 9 were compiled for MLRA 105 by Carmen Sandretto of the Economic Research Service, USDA.

shield the soil surface from impact and runoff, including rapid snowmelt, in the same manner as permanent vegetative cover.[15] Retaining heavy residues on the soil surface from present high-yielding corn is not only effective in controlling erosion and can also help restore the humus content and productivity lost from previous erosion.

As of 1994, no-till farming as the most effective and clearly defined form of conservation tillage had been adopted on about 440,000 acres (12 percent) of the land planted to row crops or small grains, compared to none in 1930 and only 3 percent in 1984, when special records on the practice were first compiled. The practice has consistently increased since 1984 according to the Conservation Technology Information Center (CTIC), a clearinghouse for information on conservation tillage supported by USDA and other Federal agencies. Also, in 1994 mulch or ridge tillage was practiced on just over a million additional acres (26 percent) of the acres in planted crops. Including all variations, the CTIC data indicate that some form of reduced tillage was practiced in the region on nearly 40 percent of the area planted to row crops or small grains in 1994.

The National Resources Inventory (NRI) also provides some estimates of additional conservation treatments needed on cropland, pastureland, and woodlands in MLRA 105. These estimates are given in table A-9. Including all variations, the CTIC data indicate that in 1994 some form of reduced tillage was practiced on nearly 40 percent of the area planted to row crops or small grains.

Conservation Reserve and Diversion Programs

In the 1992 Census of Agriculture, about 66,000 acres of the croppable land (less than 1 percent) in the region were reported as being in various set-aside or similar short-term diversion programs of USDA. These programs are apart from the Conservation Reserve Program (CRP), which aims to retire highly erodible cropland from production through long-term (10-year) contracts with landowners. Contract files indicate that a cumulative total of nearly 726,000 acres in the

[15] On this point Uhland describes counts made at Bethany, Missouri of the number of water drops falling 30 centimeters required to disperse a soil aggregate about the size of a pea and wash it through a 20-mesh screen. Only 6.2 drops of water falling 30 centimeters were required to entirely disperse an average aggregate from soil that had been cropped annually to corn. This was contrasted to a requirement of 37.7 drops to disperse aggregates taken from first-year meadow, 41.2 drops for aggregates after two years of meadow, and 40.2 drops for aggregates taken from land that had been in alfalfa for 13 years (Uhland,1949,p.2).

Table 9. Soil loss rates in excess of 'T' by crop groups and land use capability subclasses for sample counties, 1930

Crop groups and LCC[1]	Clayton County Iowa	Houston County Minnesota	Winona County Minnesota	Crawford County Wisconsin	Vernon County Wisconsin	Average for all counties	Cropland eroding above 'T'
	Estimated excess rates of soil loss in 1930, tons/ac/yr						Percent
Group AB	5.9	6.8	4.7	5.7	7.3	5.8	69.0
Class I	0.5	0.6	1.0	0.3	0	0.9	12.3
Sc IIe	6.1	6.9	0	5.7	7.3	6.0	87.9
Sc IIw	5.6	1.0	0.4	4.8	0	5.0	22.3
Group C	11.2	17.7	18.2	18.8	11.9	15.8	91.4
Sc IVe	11.3	17.8	18.3	18.8	11.9	15.8	99.7
Sc IIs	0	0	0	0	0	0	0
SC IIIs	0	0	0	0.3	0	0.3	0.3
SC IVs	0	0	0	1.7	0	1.7	1.7
Group D	15.2	10.6	3.3	25.9	15.4	13.5	99.0
SC IIIe	15.2	10.6	3.3	26.0	15.4	13.4	99.0
All groups	13.2	10.8	5.8	19.6	12.3	11.9	87.2[1]

[1] Total cropland area for all groups, crops and land use capability classes in 1930 was 647,300 acres; cropland area eroding in excess of 'T' in 1930 is estimated at 564,462 acres.

1944 scene of contour stripcropping system on the Workler Brothers farm. Garnavillo, Iowa is in the background. National Archives photo. (Iowa 1194).

1995 repeat photo: Stripcropping is no longer practiced but contour farming is still used with conservation tillage. Photo by Douglas Helms, NRCS/USDA. August 1995.

Table 10. Erosion > 'T' in 1930, 1982 and 1992 in the 28 counties predominantly in the Northern Mississippi Valley Loess Hills (MLRA 105)

Items	1930	1982	1992	Percent changes		
				1930-82	1930-92	1982-92
1. Cropland eroding excessively, 1,000 ac	3,438	2,260	1,764	-34	-49	-22
a. As percent of all principal crops	87.0	44.4	38.5	--	--	--
2. Gross erosion rate, tons/ac/yr	16.7	14.9	13.4	-11	-10	-11
3. Excess erosion rate, tons/ac/yr	11.9	10.4	8.9	-13	-25	-15
4. Average tolerance rate, tons/ac/yr	4.8	4.5	4.5	--	--	--
5. Gross erosion, 1,000 tons/yr	58,136	33,674	23,638	-42	-60	-30
6. Excess erosion, 1,000 tons/yr	41,277	23,504	15,670	-43	-62	-33
a. As percent of item 5	71	70	66	--	--	--
b. As percent of all cropland erosion	70	59	54	--	--	--

Item Explanations

Item 1. Data for 1982 and 1992 from the National Resources Inventory, except that cropland areas for all years are based on acreages as reported in the 1930, 1982 and 1992 Censuses of Agriculture. Acreages estimated by applying the percentages in 1a to the total area in principal crops given in table 8. The percentage in 1a for 1930 is from a detailed analysis for the five sample counties of any excessive erosion for the same 437 soil series/phase designations used to estimate total erosion for the region .

Items 2 and 3. Gross and excessive erosion rates per acre per year for 1930 are from the detailed sample county analysis for 437 soils or soil complexes, of which 327 involved one or more rotation combinations where excessive erosion occurred in 1930. The excess erosion rate is the erosion rate in excess of the tolerance rate 'T', weighted by the area over which it occurs. That is, excess rate = [Sum (gross erosion rate - T) times area involved] / Sum (all areas), where only the areas eroding above T are considered.

Item 4. The tolerance or 'T' values for the soils in the study area range between 2 and 5 tons per acre per year. This is the rate of displacement above which appreciable losses of soil productivity can occur because of erosion processes. The average 'T' can be approximated as the difference between the average gross and excessive rates of erosion.

Item 5. Gross erosion on land eroding excessively estimated as the product of item 1 and the gross erosion rates per acre in item 2.

Item 6. Excess erosion estimated as the product of item 1 and the excessive erosion rates per acre in item 3.

region were in the Conservation Reserve in 1994. The enrollments accounted for roughly 85 percent of all cropland not harvested in the region, and for 18 percent of the cropland considered highly erodible. The CRP acreage was about 1/7th as large as the combined area in row crops, small grains and meadow.[16]

For the seven years 1986-1992 the Consolidated Federal Funds Report indicates that, in 1992 prices, Federal rental payments to farmers under the CRP for the 28 counties in MLRA 105 have averaged about $1.0 million per county per year. The average for the five sampled counties alone was $1.8 million per county per year, and for the 23 nonsampled counties was $960 thousand per county per year. This is generally consistent with the proportions of cropland classed as highly erodible. Highly erodible cropland in the five sample counties averages 67.5 percent of all cropland, according to NRI data for 1982, 1987 and 1992. The proportion of cropland highly erodible in the 23 counties not sampled averages 60 percent.

The CRP doubtless has been important in protecting previously farmed land. The vegetative cover of the CRP areas is likely grass or trees, and thus not included in the cropland area for which we calculated per-acre erosion rates. Between 1982 and 1992 there was a net reduction of 507,000 acres in the area devoted to principal crops for which erosion rates were estimated, but it was not possible to allocate the reductions in total erosion between 1982 and 1992 specifically to the CRP, because the enrolled land was not necessarily used for crops in 1982.

The contribution of conservation practices to reduced erosion and sedimentation in the Trimble and Lund study can be verified by examining Census of Agriculture reports on land use changes from 1930-1974 and from 1974-1992, particularly the changes in corn and other row crops in Monroe, Vernon and La Crosse counties in Wisconsin.

The acres in row crops in the three counties increased between 1930 and 1992 by 136 percent, or from 75.8 thousand acres in 1930 to 178.7 thousand acres in 1992. The 1992 figure includes 22.9 thousand acres of highly erodible land in the Conservation Reserve Program. Further, about 73 percent of the 1930-92 gain for row crops occurred in the interval from 1930 to 1974.

Watershed Protection

Under the Watershed Protection and Flood Prevention Act of 1954 and its various amendments (Public Law 566), six watershed projects have been initiated in the sample counties and at least 20 more in other counties within MLRA 105 (figure 10). The required or recommended

---

[16] Data on enrollments in the CRP for the 28 counties principally in MLRA 105 were provided by Tim Osborn of the Economic Research Service, USDA.

Table 11. Erosion control and other conservation practices in 1982, 1987, and 1992 in MLRA 105.

Practices [1]	Extent in 1982	Extent in 1987	Extent in 1992
	1,000 ac	1,000 ac	1,000 ac
A. Cropland Practices:	4,203.6	4,770.2	5,422.9
327 Conservation cover	NR	NR	643.0
329 Conservation tillage (NRI)[2]	1,237.3	1,664.2	1,695.8
Conservation tillage (CTIC)[2]	NR	NR	1,335.2
330 Contour farming	900.3	884.9	1,000.6
392 Field windbreaks	36.8	39.2	34.0
393 Filter strips	0	0.1	0.1
412 Grass waterways/outlets	823.0	897.8	1,057.1
585 Stripcropping, contour	1,091.8	1,164.7	1,216.2
586 Stripcropping, field	NR	NR	2.2
589 Stripcropping, wind	7.8	3.6	4.3
600 Terraces	108.3	119.7	130.2
B. Grazing Land Practices:	398.3	275.9	436.1
342 Critical area planting	NR	NR	26.6
410 Grade stabilizations	59.9	66.3	68.0
510 Pasture/hay management	262.3	167.2	256.1
528 Proper grazing use	76.1	42.4	85.4
C. Woodland Practices:	165.6	209.8	266.2
612 Tree planting	63.9	102.4	82.1
654 Improved wood harvest	NR	NR	109.4
666 Woodland improvement	101.7	107.4	74.4
Totals, all practices	4,767.5	5,255.9	6,125.2

[1] Practices as coded and sampled in the 1992 National Resources Inventory (NRI). Margins of error not available for this NRI data set. NR = not reportable or comparable for 1982 and 1987.

[2] NRI = estimate from National Resources Inventory; CTIC = estimate from Conservation Technology Information Center.

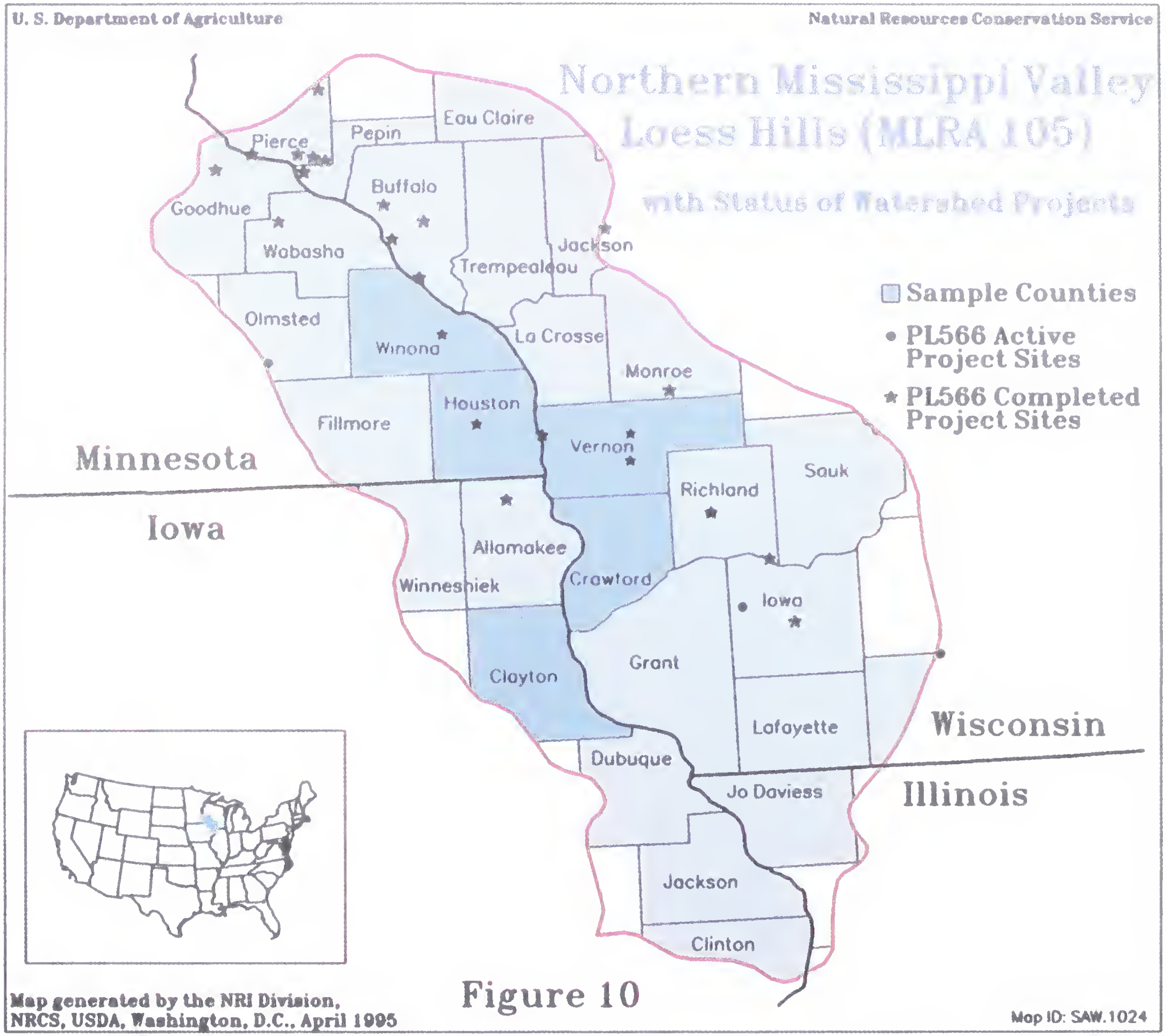

U. S. Department of Agriculture
Natural Resources Conservation Service
Northern Mississippi Valley
Loess Hills (MLRA 105)
with Status of Watershed Projects
Sample Counties
PL566 Active Project Sites
PL566 Completed Project Sites
Pierce
Pepin
Eau Claire
Goodhue
Buffalo
Wabasha
Jackson
Trempealeau
Olmsted
Winona
La Crosse
Monroe
Fillmore
Houston
Vernon
Sauk
Richland
Minnesota
Iowa
Allamakee
Winneshiek
Crawford
Iowa
Clayton
Grant
Lafayette
Wisconsin
Dubuque
Jo Daviess
Illinois
Jackson
Clinton
Map generated by the NRI Division,
NRCS, USDA, Washington, D.C., April 1995
Map ID: SAW.1024

Figure 10

land treatment measures and/or structural improvements have been completed in 23 of the projects. Regulations implementing the legislation required that a minimum of 50 percent of the land tributary to structures have recommended conservation treatments in place, meaning that erosion rates have been brought down to tolerance (T) levels for the soils concerned. In practice the areas so treated run at least 75 percent and in many cases 100 percent (Miller,1995).[17]

Assessing the specific benefits and costs of watershed projects in MLRA 105 was not an objective of this study, but available data indicate that the annual flood prevention benefits from land treatment and structural measures in the 25 watershed projects in MLRA 105 average about \$170 per acre of floodplain affected. A general requirement for economic feasibility in authorizing watershed works of improvement is that expected annual benefits be at least equal to average annual costs, including amortized initial investments and operating and maintenance costs.

Benefits are calculated as the reduction in average annual flood damages that were occurring under predevelopment conditions. Estimated average annual benefits per floodplain acre are \$105 for the two projects in MLRA 105 in Iowa, \$285 per acre for the six Minnesota projects, and \$36 per floodplain acre for the 17 projects in Wisconsin. These benefit estimates are adjusted to 1993 price levels.

Evaluations by Trimble and Lund in 10 subbasins within the Coon Creek Basin area, covering parts of La Crosse, Monroe and Vernon counties in Wisconsin, illustrate how improved land use, conservation practices, and impoundment structures interact in producing benefits. They found that the gross erosion rates averaged across all land uses in the tributary areas they studied were reduced from 13.4 tons/ac/yr in 1934 to 3.28 tons/ac/yr in 1974. The reductions ranged between a minimum of 69 to up to 80 percent in particular subbasins. Gully erosion had been fully contained. Sediment delivery ratios (reservoir deposition as a percent of gross erosion) for the years 1962-75 averaged 7.8 percent. Sediment yield was virtually eliminated by improved land management and conservation practices, as was the net rate of sedimentation on floodplains (Trimble and Lund,1982,pp.10-13,21). Average annual flood damage reduction benefits in the still-active Coon Creek Project are estimated at 1993 prices to be about \$20 per acre for the 1,300 acres of floodplain (Miller,1995).

---

[17] Estimates in this section of the flood prevention benefits of Public Law 566 watershed projects in Illinois, Iowa, Minnesota and Wisconsin have been provided by Dennis Miller of the NRCS State Office for Iowa.

Possible Related Studies

The Northern Mississippi Valley Loess Hills (MLRA 105) studied here typify water-related sheet and rill erosion conditions. Candidate areas for possible similar studies are listed in Appendix D, with notes on the extent of erodible land, major crop and livestock enterprises, and the severity of erosion problems evaluated in the Reconnaissance Erosion Survey of 1934 (RES). The information is largely from the RES reports, recent agricultural censuses, and the manual Major Land Resource Regions and Areas of the United States (USDA,1981).

For MLRA 105 the national RES reports indicated that much of the steeply rolling land bordering the Volga River in Clayton County, Iowa was severely eroded in 1934, although overall, a relatively small portion of the Mississippi loess region in Iowa had been eroded severely (U.S. National Resources Planning Board,1936,p.65, hereinafter the U.S.Board).

Iowa: At a more specific level, the RES was conducted, tabulated, and published for all 100 counties in Iowa (Walker and Brown,1936). Clayton County especially, but also Jackson and Winneshiek Counties within MLRA 105, were eroding most severely. The two counties accounted for about 60 percent of all moderately eroding and for over 75 percent of the severely eroding land in the six Iowa counties in MLRA 105. Unfortunately, while the Walker-Brown report contains county and even some township erosion data for both urban and rural land in the State, it does not focus clearly on cropland or other agricultural areas. A similar State-level report was prepared for Missouri (Baver,1935). It described severe erosion conditions in agriculture, but as in Iowa the county data were also for all lands, not for cropland or other farm uses.

Minnesota: In Minnesota the RES indicated that the major area of sheet and gully erosion extended from Wright County southward along the Mississippi River to the Iowa and Wisconsin borders (U.S.Board,p.71). No reference to a detailed State RES report for Minnesota was found, but a good insight into how the soil and erosion surveys of the time were conducted was obtained by Helms in a personal interview with Robertson (Helms,1982b).

Wisconsin: The RES also found serious erosion problems in the southwestern Wisconsin counties along the Mississippi River. About 3 million acres had lost from 25 to 75 percent of their topsoil. These lands were also severely gullied, primarily because of excessive grazing on forest land and the cultivation of very steep slopes (U.S.Board,1936,p.93).

A later erosion survey conducted by the Soils Department at the University of Wisconsin categorized erosion by degrees of severity on <u>cropland</u> for all counties in the State, ranging from

negligible. slight, medium, and severe on up to extreme, with the degree determined by the inches of topsoil lost (Muckenhirn and Zeasman, ca.1940).[18]

Results of the 1940 Survey for the 15 Wisconsin counties in MLRA 105 are in table A-12. If a suitable 'benchmark' year could be established on when such losses effectively began in each county, it may be possible to approximate average annual erosion rates in tons/ac/yr from the benchmark year up to the survey year 1940. While probably interesting, the erosion rates determined in such an exercise could not be compared with the rates estimated in our MLRA 105 study using the Universal Soil Loss Equation,

Texas: The Reconnaissance Erosion Survey in Texas was conducted at two levels: (1) The entire State was surveyed using the national erosion classifications and criteria; and (2) a companion and more specific survey was made for the Brazos River Watershed, an area of 42,400 square miles, roughly 2.25 times as large as the Northern Mississippi Valley Loess Hills.

The Brazos Basin includes all or parts of 105 counties and cuts across seven Major Land Resource Areas. The Brazos survey dealt with water-related erosion, and estimated the acres of land eroded to various degrees for several categories: cultivated land with sheet erosion, gullied cultivated land not terraced, terraced cultivated land, pasture gullied or not gullied, and woodland gullied or not gullied (Geib and Goddard,1934). The proportions of topsoil lost were not estimated.

One alternative for comparing current erosion conditions with those existing at the time of the Brazos Survey would involve replicating the MLRA 105 study, for one or more of the land use categories above. The USLE erosion rates reconstructed for the base year 1934 would be compared with USLE rates from the National Resources Inventories for 1992 or other years.

A second alternative would compare over time such measures as the acres in various land uses and/or land use capability classes with erosion limitations, and the acres adequately or not adequately treated. This approach could perhaps use information of this kind compiled in the National Resources Inventories (NRI) and similar inventories dating back to 1958.

A third alternative is to evaluate wind erosion conditions over time within a region where wind erosion was the major problem identified in the 1934 Reconnaissance Erosion Survey. In this case the recommended standard of comparison would be the Revised Wind Erosion Equation (RWEQ) as applied to the year 1934 and to the 'present' time for a selected and relatively small area. The RWEQ is still being developed.

---

[18] In his study of rotations and soil erosion Uhland determined that an acre-inch of topsoil weighs from 142 to 152 tons (Uhland,1949,p.2).

References

Ball, A. Gordon and Earl O Heady. 1957. *Economic Evaluation of Use of Soil Conservation and Improvement Practices in Western Iowa.* Technical Bulletin No. 1162, Agricultural Research Service and Soil Conservation Service, U.S. Dept. Agr. with Iowa Agr. Expt. Sta. 91pp.

Barnard, C.H. and J.Jones. 1987. *Farm Real Estate Values in the United States by Counties, 1850-1982*. U.S. Dept. Agr. Stat. Bul. No. 751. 111pp.

Baver, L.D. 1935. *Soil Erosion in Missouri*. Bul. No. 349, Missouri Agr. Expt. Sta. 65pp.

Beach, Timothy. 1994. "The Fate of Eroded Soil: Sediment Sinks and Sediment Budgets of Agrarian Landscapes in Southern Minnesota, 1851-1988". *Annals of the Association of American Geographers 84*:5-28.

Benton,J.H. and A.L. Gray. 1925. *Soil Survey of Clayton County, Iowa*. U.S. Department of Agriculture, Bureau of Chemistry and Soils, with Iowa Agr. Expt. Sta. 31pp.

Bowman, Mark and David Gibney. 1995. Conference with G.A. Pavelis at Elkader, Iowa. February 6,1995.

Brown, M.H. and I.F. Nygard. 1936. *Erosion and Related Land Use Conditions in Winona County, Minnesota*. U.S. Dept. Agr.,Soil Conservation Service, Erosion Survey No. 17. 27pp.

Browning, G.M. 1948. *Investigations in Erosion Control and Reclamation of Eroded Land at the Missouri Valley Loess Conservation Experiment Station, Clarinda, Iowa, 1931-42*. U.S. Dept. Agr., Soil Conservation Service, with Iowa Agr. Expt. Sta. 88pp.

Bunce, Arthur C. 1942. *A Method of Estimating the Economic Effects of Planned Conservation on an Individual Farm.* U.S. Department of Agriculture Misc. Pub. No. 463. 28pp.

Coutu, Arthur J., W.W. McPherson, and Lee R. Martin. 1959. *Methods for An Economic Evaluation of Soil Conservation Practices*. Tech. Bul. No. 137, North Carolina Agr. Expt. Sta. 46pp.

Edwards, M.J., 1928. *Soil Survey of Vernon County, Wisconsin*. U.S. Dept. Agr., Bureau of Chemistry and Soils, with Wisconsin Agr. Expt. Sta. 43pp.

Edwards, M.J., et.al. 1930. *Soil Survey of Crawford County, Wisconsin*. U.S. Dept.Agr., Bureau of Chemistry and Soils, with Wisconsin Agr. Expt. Sta. 38pp.

Geib, H.V. and Ira T. Goddard. 1934. *Reconnaissance Erosion Survey of the Brazos River Watershed, Texas*. U.S. Dept. Agr, Misc. Pub. No. 186. 47pp.

Goebel, J.Jeffery. 1992. "Description of the National Resources Inventory". Appendix A in *Agricultural Chemical Use and Ground Water Quality: Where Are the Potential Problem Areas?* Unnumbered Report, Soil Conservation Service, U.S. Dept. Agr.,with other cooperators. 65pp.

Gray, A.L., et.al. 1929. *Soil Survey of Houston County, Minnesota.* U.S.Dept. Agr., Bureau of Chemistry and Soils, with Minnesota Agr. Expt. Sta. 36pp.

Grubb, H.W. and G.S. Tolley. 1966. *Benefits and Costs of Soil Conservation in the South and its Subregions*. Tech. Bul. No. 172. North Carolina Agricultural Experiment Station. 58pp.

Hays, Orville E. and Noble Clark. 1941. *Cropping Systems That Help Control Erosion*. Bul. No. 452. Wisconsin State Soil Conservation Committee with Soil Conservation Service, U.S. Dept. Agr and Wisconsin Agr. Expt. Sta. 23pp.

Hays, O.E. et.al. 1949. *Investigations in Erosion Control and Reclamation of Eroded Land at the Upper Mississippi Valley Conservation Experiment Station near La Crosse, Wisc., 1933-43*. U.S. Dept. Agr.,Soil Conservation Service, with Wisconsin Agr. Expt. Sta. 87pp.

Heady, Earl O. and Harald R. Jensen. 1951. *The Economics of Crop Rotations and Land Use*. Research Bul. No. 383. Iowa Agr. Expt. Sta. 459pp.

Helms, Douglas. 1982a. "Coon Valley, Wisconsin: A Conservation Success Story" In *Readings in the History of the Soil Conservation Service*. U.S. Dept. Agr., Soil Conservation Service, Historical Notes. No.1. pp51-53.

Helms, Douglas. 1982b. "Oral History Interview with Alex Robertson", September 24-25, 1982 (unpublished Soil Conservation Service report).48pp.

Hendrickson, Ida. 1995. Personal communication, January 20, 1995. (Ms. Hendrickson is the president of a local saddle club in Clayton County, Iowa).

Illinois Agricultural Statistics Service. 1951. *Illinois Agricultural Statistics, County Estimates for the 20 years ending January 1,1945*. Circular 446, 305pp. (Additional bulletins and data for subsequent years provided May 6,1994 by Gary D. Kepley, Deputy State Statistician).

Iowa Agricultural Statistics (formerly Iowa Crop and Livestock Reporting Service. 1978 and 1990. *Iowa Crops: County Estimates, Historic Series,1950-77, and Iowa Crop County Estimates: Historical Series, 1975-79.* Additional photocopies of county-level crop acreages and yields dating from 1930 provided May 1994 by the State Statistician).

Johnson, Leonard C. 1991. *Soil Conservation in Wisconsin: Birth and Rebirth.*(Madison,Wisc.: University of Wisconsin). 332pp.

Kellogg, Robert L., Gale W. TeSelle and J. Jeffery Goebel. 1994. "Highlights from the 1992 National Resources Inventory". *J. Soil and Water Conservation 49(6); 521-527.*

Klingebiel, A.A. and P.H. Montgomery. 1961. *Land Capability Classification*. Soil Conservation Service, U.S. Dept. Agr. Handbook No. 210. 21pp.

Kuehl, Ronald J., et.al. 1982. *Soil Survey of Clayton County, Iowa*. U.S. Dept. Agr., Soil Conservation Service with Iowa Agr. and Home Economics Experiment Station. 250pp.

Lyles, Leon. 1985. "Predicting and Controlling Wind Erosion". In *The History of Soil and Water Conservation*. (Eds. Douglas Helms and Susan L Flader). Washington, D.C.: The Agricultural History Society. pp103-112.

Marschner, F.J. 1959. *Land Use and Patterns in the United States*. U.S. Dept.Agr. Agr. Res. Service. Agr. Handbook No. 153. 276pp.

Meyer, L. Donald and William C. Moldenhauer. 1985. "Soil Erosion by Water: The Research Experience". In *The History of Soil and Water Conservation*. (Eds. Douglas Helms and Susan L. Flader). Washington, D.C.: The Agricultural History Society. pp90-102.

Miller, Dennis. 1995. Informal communication, 6 March 1995, State Office for Iowa of the Natural Resources Conservation Service, U.S. Department of Agriculture.

Minnesota Agricultural Statistics Service. 1994. Detailed photocopies of crop acreages and yields from 1930-1975 provided May 17,1994 by George Howse, Deputy Statistician.

Muckenhirn, R.J. and O.R. Zeasman. ca.1940. *Soil Erosion in Wisconsin*. Wisconsin University Special Report. Undated report based on field work completed June 1940. 24pp.

Padgitt, Merrit, M. 1980. *An Analysis of On-Farm Impacts of Soil Conservation and Non-Point Source Pollution Abatement Practices and Policies on Representative Farms in Southeast Minnesota*. Unpubl. Ph.D. Dissertation, Michigan State University. 85pp.

Pavelis, George A., Howard P. Johnson, William D. Shrader, and John F. Timmons. 1961. *Methodology of Programming Small Watershed Development*. Res. Bul. No. 493, Iowa Agr. Expt. Sta. with Economic Research Service, U.S. Dept. Agr. 160pp.

Pavelis, George A. 1985. *Conservation and Erosion Control Costs in the United States*. Staff Rpt. No. AGES850423, Economic Research Service, U.S. Dept. Agriculture. 30pp.

Perfect, D.E. and D.E. Sheetz. 1942. *Physical Land Use Conditions on the Farmersburg-McGregor Project, Clayton County, Iowa*. U.S.Dept. Agr., Soil Conservation Service. Physical Land Survey No. 28. 25 pp.

Schwab, Glenn O., R.K. Frevert, T.W. Edminster and K.K. Barnes. 1955. *Soil and Water Conservation Engineering*. New York: John Wiley and Sons. 475pp.

Smith, D.D., et.al. 1945. *Investigations in Erosion Control and Reclamation of Eroded Shelby and Related Soils at the Conservation Experiment Station, Bethany, Mo., 1930-42*. U.S.Dept. Agr., Soil Conservation Service, with Missouri Agr. Expt. Sta. 175pp.

Strohbehn, Roger. 1986. *An Economic Analysis if USDA Erosion Control Programs: A New Perspective*. U.S. Dept. Agr., Econ. Res. Service. Agricultural Economic Report No. 560. 60pp.

Trimble, Stanley W. 1974. *Man-Induced Soil Erosion on the Southern Piedmont,1700-1970*. Ankeny, Iowa: Soil Conservation Society of America. 180pp.

Trimble, Stanley W. and Steven W. Lund. 1982. *Soil Conservation and the Reduction of Erosion and Sedimentation in the Coon Creek Basin, Wisconsin*. U.S. Geological Survey Professional Paper No. 1234. 35pp.

Trimble, Stanley W. 1985. "Perspectives on the History of Soil Erosion Control in the Eastern United States". In *The History of Soil and Water Conservation*. (Eds. Douglas Helms and Susan L. Flader). Washington, D.C.: The Agricultural History Society. pp.60-78.

Uhland,R.E. 1949. *The Value of Crop Rotations for Soil and Water Conservation*. SCS-TP-83. Soil Conservation Service, U.S. Dept. Agriculture. 12pp.

U.S. Department of Agriculture, Soil Conservation Service. 1939. *Project Monograph, Coon Valley and Coon Creek Project Report (Region 5, Wisc. 1)*. 107pp.

______________, Natural Resources Conservation Service. 1995. *Summary Report: 1992 National Resources Inventory (revised)*. Unnumbered Rpt. with Iowa State University Statistical Laboratory. 54pp.

______________, Soil Conservation Service, Conservation Needs Inventory Committee. 1962. *Basic Statistics of the National Inventory of Soil and Water Conservation Needs, 1958*. Statistical Bulletin No. 317. 163pp.

______________, Soil Conservation Service. 1971. *Basic Statistics: National Inventory of Soil and Water Conservation Needs, 1962*. Statistical Bulletin No. 461. 210pp.

______________, Soil Conservation Service with Iowa State University Statistical Laboratory. 1987. *Basic Statistics: 1982 National Resources Inventory*. Statistical Bulletin No. 756. 153 pp.

______________, Soil Conservation Service. 1981. *Land Resource Regions and Major Land Resource Areas of the United States*. Agr. Handbook No.296. 156pp.

_______________, Bureau of the Census. 1931. Fifteenth Census of the United States: 1930. *Agriculture: Vol. I Farm Acreage and Farm Values by Townships and Minor Civil Divisions, and Vol. II, Part I: Reports by States, with Statistics for Counties and a Summary for the United States; The Northern States*. 1385pp.

_______________, Bureau of the Census. 1936. United States Census of Agriculture: 1935. *Vol. I, Statistics by Counties with State and U.S. Summaries.*

_______________, Bureau of the Census. 1994a. Census of Agriculture: 1992. *Vol. I Geographic Area Series, State and County Data. Parts 13 (Illinois), 15 (Iowa), 23 (Minnesota), and 49 (Wisconsin).*

_______________, Bureau of the Census. 1994b. *County and City Data Book: 1994, A Statistical Abstract Supplement*. Washington, D.C. Government Printing Office. 928pp.

_______________, Bureau of the Census, Economics and Statistics Administration. 1994c. *Consolidated Federal Funds Report, 1983-1992*. Information on CD-ROM accessed by Catherine Kascak, Economic Research Service, U.S. Department of Agriculture.

U.S. National Resource Planning Board, Land Planning Committee. 1936. *Soil Erosion: A Critical Problem in American Agriculture*. Part V of the Supplementary Report of the Land Planning Committee. See Sec. V, Erosion Conditions in the United States, p.23ff and Sec. IX, Erosion Conditions by States, p.55ff.

Walker, R.H. and P.E. Brown. 1936. *Soil Erosion in Iowa*. Special Report No. 2, Iowa Agr. Expt. Sta. with Soil Conservation Service, U.S. Dept. Agr. 46pp.

Wischmeier, W.H. 1976. "Use and Misuse of the Universal Soil Loss Equation". *J. of Soil and Water Conservation* 31:5-9.

Wischmeier, Walter H. and Dwight D. Smith. 1978. *Predicting Rainfall Erosion Losses: A Guide to Conservation Planning*. Agr. Handbook No. 537, U.S. Dept. Agr., Science and Education Administration. 58pp.

Appendix A
Supplemental Tables
(Short titles)

Table A-1. Land use patterns in 1930 and 1992 for five sample counties versus all 28 counties in MLRA 105 72

Table A-2. Pasture and woodland use in 1930 and 1992 for five sample counties versus all 28 counties in MLRA 105 73

Table A-3. Crop and agricultural land uses in 1930 for five sample counties. 74

Table A-4. Major cropland use in 1930 for five sample counties 75

Table A-5. Average annual yield estimates for 1930 conditions in sample counties 76

Table A-6. USLE 'C' Factors, 1930 conditions, Low Productivity Levels 77

Table A-7. Distribution of rotations and crops in Clayton County, Iowa in 1930 79

Table A-8. Principal cropland uses and soil erosion in 1930 and 1992 in MLRA 105 80

Table A-9. Remaining erosion control needs in 1992 on cropland, pastureland, forest land, and other land uses in MLRA 105 81

Table A-10. Comparison of 1992 National Resources Inventory and Census of Agriculture estimates of cropland and other land uses in MLRA 105 82

Table A-11. Sheet and rill erosion rates on cropland and other land uses in the 1992 NationalResources Inventory for MLRA 105 83

Table A-12. Soil erosion in 1940 in the 15 Wisconsin counties in MLRA 105, by degrees of erosion and approximate inches of topsoil lost 84

Table A-1. Land use patterns in 1930 and 1992 for five sample counties versus all 28 counties in MLRA 105, the Northern Mississippi Valley Loess Hills

Crop and Land Use Items	5 sample counties 1930[1]	5 sample counties 1992[1]	MLRA 105 total 1930	MLRA105 total 1992	MLRA105 change, 1930-1992
	1,000 ac	1,000 ac	1,000 ac	1,000 ac	Percent
A. Principal crops	647	756	3,952	4,583	15
1. Row crops	238	454	1,187	2,748	131
2. Close-grown crops	260	51	1,650	316	-81
3. Rotation meadow	149	251	1,115	1,519	36
B. Net cultivated [2]	640	749	3,915	4,530	15
C. Other harvested crops[3]	226	81	1,240	192	-85
D. Cropland harvested (B+C)	866	830	5,155	4,722	-9
E. Cropland not harvested	41	121	212	796	--
1. Crop failure	8	7	37	53	43
2. Conservation Reserve[4]	33	105	175	677	--
3. Diversion programs[4]	--	9	--	66	--
F. All croppable land (D+E)	907	951	5,367	5,518	2
G. Noncroppable land	1,083	740	5,700	3,783	-34
1. Cropland only grazed[5]	175	133	1,224	770	-38
2. Pasture, not wooded	158	114	1,229	670	-46
3. All woodland	660	434	2,704	1,779	-35
4. Farmsteads and other land	90	59	543	564	3
H. All land in farms (F+G)	1,990	1,691	11,067	9,301	-16
I. Number of farms	12,891	6,720	71,048	35,330	-50

[1] Sample counties: Clayton (Iowa); Houston and Winona (Minnesota); and Crawford and Vernon (Wisconsin).
[2] Less than item A by failed crops (item E1).
[3] Includes hay not in rotation, fruits, and other minor crops.
[4] Items not applicable in 1930; Percent changes not computed. Item E2 includes small idle acreage not CRP.
[5] For this study cropland only grazed and not in rotation is considered as pastureland.

Table A-2. Pasture and woodland use in 1930 and 1992 for sample counties versus all 28 counties in MLRA 105

Pasture and woodland uses	Five counties 1930	MLRA 105 total 1930	MLRA 105 total 1992	MLRA 105 change 1930-1992
	1,000 ac	1,000 ac	1,000 ac	Percent
A. All land pastured or grazed [1]	907	4,641	2,236	-52
1. Woodland grazed	574	2,188	796	-64
2. Permanent pasture, not wooded	158	1,229	670	-45
3. Cropland used for pasture	175	1,224	770	-37
B. All woodland in farms [1]	660	2,704	1,779	-34
1. Woodland grazed	574	2,188	796	-64
2. Woodland not grazed	86	516	983	90
C. Woodland grazing, 1,000 acres	574	2,188	796	-64
1. Percent of all grazing, (A1/A)	(63)	(47)	(35)	--
2. Percent of all woodland, (B1/B)	(87)	(81)	(45)	--
D. All land in farms, 1,000 acres	1,990	11,067	9,147	-18
1. Percent used for pasture, (A/D)	(45)	(42)	(24)	--
2. Percent in woodland, (B/D)	(33)	(24)	(19)	--

Source: Censuses of Agriculture for 1930 and 1992.

[1] Items A and B are not additive; note that grazed woodlands are an element of both A and B.

Table A-3. Crop and agricultural land uses in 1930 for five sample counties in the Northern Mississippi Valley Loess Hills (MLRA 105)

Crop and Land Use Items	Clayton County, Iowa	Houston County, Minnesota	Winona County, Minnesota	Crawford County, Wisconsin	Vernon County, Wisconsin
	1,000 ac	1,000 ac	1,000 ac	1,000 ac	1,000 ac
A. Principal crops	219.0	94.5	147.1	73.1	113.6
B. Net harvested [1]	216.2	93.8	145.2	72.2	112.5
C. Other harvested crops	20.0	46.0	37.6	40.9	81.1
1. Fruits and minor crops	3.4	2.5	4.1	1.9	4.2
2. Hay, w/o rotation hay [2]	16.6	43.5	33.5	39.0	76.9
D. Cropland harvested, (B+C)	236.2	139.8	182.8	113.1	193.6
E. Cropland not harvested	9.3	3.4	5.8	8.3	4.8
1. Crop failure (see B)	3.0	0.7	1.9	0.9	1.1
2. Cropland idle	6.3	2.7	3.9	7.4	3.7
F. All cropped land, (D+E)	245.5	143.2	198.6	121.4	198.4
G. Non cropped land	218.5	190.3	177.3	206.7	290.4
1. Cropland only grazed	61.1	25.0	24.1	22.2	42.4
2. Pasture, not wooded	39.1	21.0	24.2	26.9	46.5
3. All woodland	94.6	129.6	112.5	140.4	182.6
4. Farmsteads or other land	23.7	14.7	16.5	17.2	18.9
H. All land in farms, (F+G)	464.0	333.5	375.9	328.1	488.8
I. Total land area, (Census)	498.9	361.6	396.8	363.5	513.3
J. Percent land in farms, (H/I)	93	92	95	91	95
K. Number of farms	2,993	1,910	2,058	1,915	4,016

Source: Censuses of Agriculture for 1930 and 1992.

[1] Less than item A by acres of failed crops (item E1). The main crops, including rotation meadow, are listed in table A-2.

[2] Rotation hay included within cultivated crop use.

Table A-4. Major cropland use in 1930 for five sample counties in MLRA 105

Cultivated Cropland Uses[1]	Clayton County, Iowa	Houston County, Minnesota	Winona County, Minnesota	Crawford County, Wisconsin	Vernon County, Wisconsin
Soil Survey Years	1925/82	1929/84	1936/94	1930/62	1928/69
	Acres	Acres	Acres	Acres	Acres
All Cultivated Cropland[2]	219,000	94,500	147,100	73,100	113,600
1. Row crops:	90,100	36,800	39,100	30,300	42,200
011 All Corn*	86,400	35,200	36,000	26,800	31,200
013 Soybeans[3]	--	--	--	--	--
016 Tobacco*	--	--	--	2,400	8,900
018 Irish potatoes*	1,400	1,000	2,100	800	1,400
019 Vegetables*	2,300	600	1,000	300	700
2. Close-grown crops:	75,500	35,800	74,600	26,100	47,800
111 Wheat*	1,300	2,000	7,900	1,100	1,400
112 Oats*	64,600	24,200	35,400	19,500	36,400
114 Barley*	9,200	8,600	26,300	5,300	9,900
116 Other; rye, flax	400	1,000	5,000	200	100
3. Rotation meadow:*	53,400	21,900	33,400	16,700	23,600
a. Clover, clover/timothy	42,800	15,830	25,186	9,015	12,027
b. Legume/grass seeds	8,168	3,663	5,891	3,836	5,266
c. Alfalfa hay	1,643	2,054	2,248	2,881	6,142
d. Sweet clover pasture	536	306	89	781	141
e. Annual legumes hayed	216	16	6	166	58

[1] Cropland uses primarily from the Census of Agriculture for 1930 and State Crop Reports.
[2] Crops with * used in estimating soil erosion in 1930 from the Universal Soil Loss Equation (USLE). Numeric codes for crops are as used in the 1992 National Resources Inventory.
[3] In 1930 soybeans were grown largely as emergency hay. Any soybean acres are within Item 3e.

Table A-5. Average annual expected yield estimates under 1930 conditions in five sample counties in MLRA 105[1]

Crop	Yield units per acre	Clayton County Iowa	Houston County Minnesota	Winona County Minnesota	Crawford County Wisconsin	Vernon County Wisconsin
Corn for grain	bu/ac	40	40	35	50	45
		A	B	E	F	G
Oats for grain	bu/ac	40	35	35	40	40
		B	B	E	F	G
Wheat grain	bu/ac	20	15	15	25	20
		C	B	E	F	G
Barley	bu/ac	30	30	30	30	35
		C	C	C	C	D,G
Rye	bu/ac	12	15	12	12	--
		C	C	C	C	--
Hay meadow	tons/ac	1.8	1.8	1.8	1.5	1.8
		D	D	D	D	D
Potatoes	bu/ac	90	100	100	100	95
		D	D	D	D	D
Tobacco	cwt/ac	--	--	--	14	12
		--	--	--	D,F	G

[1] Letters below each estimate identify primary sources as A, B, C, etc. If data were not available for a particular county, the estimates are based on reports available for nearby areas.

A. Clayton County and Northeast Iowa District average, 1929-35
B. Houston County, Minnesota and Southeast Minnesota District average, 1929-35
C. Jo Daviess County, Illinois and Northwest Illinois District average, 1925-35
D. 1930 Census of Agriculture for the County
E. Winona County and Southeast Minnesota District average, 1929-35
F. Soil-based estimates from the 1930 Crawford County Soil Survey
G. Soil-based estimates from the 1928 Vernon County Soil Survey

Table A-6. USLE 'C' Factors, MLRA 105, 1930 conditions, Low Productivity Levels *

No.	Crop Sequence	Residue Management	Tillage		
			Fall MP	Spring MP	Spring Disk
006	Corn after grass-legume meadow	Harvest for grain, residue left	0.36	0.26	---
007	Corn after grass-legume meadow	Residue grazed after harvest for grain, or standing crop grazed	0.36	0.27	---
009	Corn after grass-legume meadow	Harvest for silage, or stover removed after harvest for grain	0.36	0.31	---
		Means, 006, 007, 009	0.36	0.28	--
016	Corn after corn, second year after grass-legume meadow	Harvest for grain, residue left	0.53	0.45	0.30
017	Corn after corn, second year after grass-legume meadow	Residue grazed after harvest for grain, or standing crop grazed	0.53	0.47	0.31
019	Corn after corn, second year after grass-legume meadow	Harvest for silage, or stover removed after harvest for grain	0.52	0.51	0.37
		Means, 016, 017, 019	0.53	0.48	0.33
021	Corn after corn, 3 + years after M	Harvest for grain, residue left	0.53	0.49	0.32
022	Corn after corn, 3 + years after M	Residue grazed after harvest for grain, or standing crop grazed	0.53	0.50	0.33
024	Corn after corn, 3 + years after M	Harvest for silage, or stover removed after harvest for grain	0.53	0.54	0.38
		Means, 021, 022, 024	0.53	0.51	0.35
026	Corn after grain, 3 + years after M	Harvest for grain, residue left	0.62	0.49	0.32
027	Corn after grain, 3 + years after M	Residue grazed after harvest for grain, or standing crop grazed	0.62	0.50	0.33
029	Corn after grain, 3 + years after M	Harvest for silage, or stover removed after harvest for grain	0.62	0.51	0.38
		Means, 026, 027, 029	0.62	0.51	0.35

--continued

Table A-6. USLE 'C' Factors, MLRA 105, 1930 conditions, Low Productivity Levels--continued

No.	Crop Sequence	Residue Management	Tillage		
			Fall MP	Spring MP	Spring Disk
034	Spring small grain after grass-legume meadow	Harvest for grain, straw removed after harvest, stubble left	0.18	0.14	---
036	Spring small grain after grain, second year after legume meadow	Harvest for grain, straw removed after harvest, stubble left	0.31	0.23	0.19
042	Spring small grain after corn, second year after grass-legume meadow	Harvest for grain, straw removed after harvest, stubble left	0.22	0.21	0.18
044	Spring small grain after grain, 3+ years after M	Harvest for grain, straw removed after harvest, stubble left	0.31	0.23	0.19
046	Spring small grain after corn, 3 + years after M	Harvest for grain, straw removed after harvest, stubble left	0.23	0.23	0.19
066	Grass-legume meadow, 1st yr, seeded w/spring small grain nurse crop	No hay harvested	0.08	0.14	0.10
070	Established grass-legume meadow	Harvested for hay	0.01	---	---
071	Irish potatoes after corn or grain, 3+ years after M (average of values from current FOTG, WI & MN	Clean tillage	0.35	0.33	0.31
073	Vegetables after corn or grain, 3+ years after M (from current FOTG, Wisconsin, average of values for snapbeans and sweet peas)	Clean tillage	---	0.50	---

* Based on a more detailed factor table prepared September, 1994 by Scott Argabright, Midwest National Technical Center, NRCS, USDA. These sequences are illustrated as applied in Clayton County, Iowa.

Table A-7. Illustrated distribution of rotations and crops in Clayton County, Iowa in 1930

Crop/Soil Groups and Rotations[1]	Rotation Distributions		Crops Distributed by Soil Groups and Rotations				
	Percent[2]	Acres	Vegetable	Potatoes	Corn	Sm. Grain	Meadow
Group AB:	100.00	58,000	2,300	1,400	29,310	20,670	4,320
CP, GP	4.83	2,800	--	1,400	700	700	--
CV, GV	7.93	4,600	2,300	--	1,150	1,150	--
CG	50.00	29,000	--	--	14,500	14,500	--
CCCGM	37.24	21,600	--	--	12,960	4,320	4,320
Group C:	100.00	11,900	--	--	--	7,933	3,967
GGM	100.00	11,900	--	--	--	7,933	3,967
Group D:	100.00	149,100	--	--	57,155	45,973	45,972
CGM	70.00	104,370	--	--	34,790	34,790	34,790
CCGM	30.00	44.730	--	--	22,365	11,183	11,182
All Groups, 1930 acres		219,000	2,300	1,400	86,465	74,576	54,259
1930 Census, acres		219,000	2,300	1,400	86,400	75,500	53,400
Pct. deviation from reports		0	0	0	< 1%	-1.2%	+1.6%
Pct. of all acres, 1930		100	1%	1%	40%	34%	24%
1992 Census, acres		259,508	10	--	[3]189,227	15,271	55,000
Pct. of all acres, 1992		100	< 1%	< 1%	74%	5%	21%

[1] Rotation crops: C=corn; G=small grains (mainly oats); M=rotation meadow; P=Irish potatoes; V=all vegetables (including sweet corn, melons, etc.).

[2] Percent denotes share of acres in each crop/soil group assigned to each crop rotation, from Argabright worksheet of 1/12/95.

[3] Acres for 'corn' in 1992 include 17,427 acres of soybeans as a comparable crop.

Table A-8. Principal cropland uses and soil erosion in 1930 and 1992 in the Northern Mississippi Valley Loess Hills (MLRA 105)

Cropland and crop groups	Cropland in group	Soil loss rate per acre[1]	Gross soil loss per year	Distribution of crops by groups		
				Row crops	Small grains	Meadow
	1,000 ac	Tons/ac/yr	1,000 tons	1,000 ac	1,000 ac	1,000 ac
Principal Crops, 1930 total	3,952	14.9	58,885	1,187	1,650	1,115
				(31)	(41)	(28)
Principal Crops, 1992 total	4,583	6.3	28,904	2,748	316	1,519
				(61)	(6)	(33)
Increase or decrease, 1930-1992	631	-8.6	-29,981	1,561	-1,334	404
Percent change, 1930-1992	(16)	(-58)	(-51)	(131)	(-81)	(36)

[1] Soil loss rates for 1930 as evaluated in this study by crops estimated grown on the various land use capability classes. Mean estimated soil loss rate for 1992 is for all crops combined, from the 1992 National Resources Inventory.

Table A-9. Estimated remaining erosion control needs in 1992 on cropland, pastureland, forest land, and other land uses in MLRA 105

Land uses	Five sampled counties	MLRA totals, 28 counties	Clayton County, Iowa only
(Margins of error in parentheses) [1]	1,000 ac	1,000 ac	1,000 ac
All cropland	347.4	2,710.5	120.4
	(51.9)	(128.2)	(23.7)
Pastureland	38.0	186.3	2.7
	(18.9)	(37.8)	(3.7)
Forest land	0	0	0
	(0)	(0)	(0)
Miscellaneous /minor uses	8.5	70.8	1.6
	(6.0)	(24.5)	(0.8)
Totals, all uses	393.9	2,967.6	124.7
	(55.7)	(132.6)	(24.3)

Source: 1992 National Resources Inventory, Natural Resources Conservation Service, USDA.

[1] Estimated acreage minus and plus the margin of error gives the lower and Northern limits of the 95-percent confidence interval.

Table A-10 Comparison of 1992 National Resources Inventory (NRI) and Census of Agriculture estimates of cropland and other land uses in MLRA 105

Land uses	Clayton County, IA		5 Sample Counties		Totals for MLRA 105	
	NRI	Census	NRI	Census	NRI	Census
(Error margins in parentheses)[1]	1,000 ac	1,000 ac	1,000 ac	1,000 ac	1,000 ac	1,000 ac
A. Principal crops	225.4	259.5	765.7	756	5,135	4,583
	(28.3)	--	(74.1)	(18.1)	(160)	(105)
1. Row/close-grown crops	173.9	204.5	508	505	3,413	3,064
	(25.4)	--	(61.1)	--	(138)	--
2. Grass/legumes	51.5	55.0	257.7	251	1,722	1,519
	(16.4)	--	(43.0)	--	(107)	--
B. Other crop uses	4.7	14.0	`12.20	138	74.7	781
	(4.4)	--	(11.8)	--	(24.7)	--
C. All cropland	230.1	273.5	777.9	894	5,209	5,364
	(28.3)	--	(74.7)	--	(161)	--
D. Pastureland	56.2	100.2	301.9	247	1,772	1,440
	(15.8)	--	(47.5)	--	(109)	--
E. Woodland/other	163.2	118.3	1,049.6	493	5,220	2,343
	(29.2)	--	(81.3)	--	(174)	--
F1. All land uses	449.5	464.0	2,129	1,634	12,201	9,147
	(14.7)	--	(74.7)	--	(125)	--
F2. Adjusted totals[2]	657	492	1,572	1,634	9,324	9,147

Sources: 1992 National Resources Inventory, USDA Natural Resources Conservation Service, and U.S. Census of Agriculture, 1992.

[1] NRI estimates of land uses minus and plus the margins of error give the lower and upper limits of the 95-percent confidence interval.

[2] F2 is an adjusted NRI estimate for all land in farms. It is obtained by subtracting from F1 the NRI estimate for woodland, etc. (E), then adding back in the Census estimate for E, all woodland and other minor farmland uses.

Table A-11. Sheet and rill erosion rates on cropland and other land uses estimated in the 1992 National Resources Inventory for MLRA 105

Land uses	Five sample counties, erosion rate 1992	MLRA 105, all 28 counties		
		Erosion rate 1992	Land uses 1992	Gross erosion 1992 [2]
(Error margins in parenthesis)[1]	tons/ac/yr	tons/ac/yr	1,000 ac	1,000 tons/yr
A. Principal crops	5.5	6.5	5,134.5	33,434
	(0.8)	(0.3)	(160.2)	(3,351)
1. Row/close-grown crops	6.7	7.9	3,412.7	27,015
	(1.0)	(0.4)	(138.0)	(2,455)
2. Grasses/legumes	3.3	3.6	1,721.8	6,251
	(1.1)	(0.5)	(106.9)	(1,245)
B. Other cropland uses	3.2	6.4	74.7	478
	(4.1)	(3.5)	(24.7)	(253)
C. All cropland	5.5	6.5	5,209.2	33,908
	(0.8)	(0.5)	(161.3)	(2,611)
D. Pastureland	1.1	1.2	1,772.1	2,148
	(0.3)	(0.2)	(109.2	(485)
E. Woodland/other	0.1	0.4	5,220.4	2,140
	--	(0.3)	(173.5)	(1,635)
F. All land uses	2.2	3.1	12,201.8	37,850
	(0.3)	(0.2)	(124.6)	(2,827)

[1] Estimated (a) erosion rates, (b) land use areas, and (c) gross erosion tonnages minus and plus the margin of error gives the lower and upper limits of the 95-percent confidence interval. For (a) and (b) the margins of error are directly from the National Resources Inventory. For (c) the margins of error are estimated as the differences between the upper (or lower) limit of calculated gross erosion.

[2] This column gives estimates of average annual erosion under 1992 land use and other conditions.

Table A-12. Soil erosion in 1940 in the 15 Wisconsin counties in MLRA 105, by degrees of erosion and approximate inches of topsoil lost

County	Total cropland area	Erosion negligible < 1.0 in.	Slight erosion 1.0-3.9 in.	Medium erosion 4.0-8.9 in.	Severe erosion 9.0-12 in.	Ruined land 12+ in.
	1,000 ac.	1,000 ac.	1,000 ac.	1,000 ac.	1,000 ac.	1,000 ac.
Crawford	371	25	30	35	7	3
Vernon	522	22	60	71	15	4
Subtotal, 2 counties	893	47	90	106	22	7
(Pct. of cropland)	(100)	(5)	(10)	(11)	(2)	(1)
Buffalo	449	32	40	43	10	10
Eau Claire	411	17	63	42	6	3
Grant	738	67	85	88	20	6
Iowa	485	26	64	66	7	2
Jackson	639	39	40	41	6	2
La Crosse	302	36	27	28	4	2
Lafayette	401	46	57	55	8	2
Monroe	583	50	54	49	8	2
Pepin	150	12	10	23	7	4
Pierce	370	39	36	66	20	6
Richland	377	16	46	50	7	2
Sauk	537	59	66	66	10	3
Trempealeau	475	67	47	42	19	6
Total, all counties above	6,810	553	725	765	154	57
(As pct. of cropland)	(100)	(8)	(11)	(11)	(2)	(1)
(As pct. of State)	(19)	(15)	(24)	(30)	(28)	(38)
Wisconsin total	35,123	3,600	3,014	2,474	542	148
(As pct. of cropland)	(100)	(10)	(9)	(7)	(2)	(<1)

Source: *Soil Erosion in Wisconsin (R.J. Muckenhirn and O. R. Zeasman).* Wisconsin University Special Report, undated report based on field surveys conducted June 1940.

Appendix B
MLRA 105, the Northern Mississippi Valley Loess Hills

Illinois, Iowa, Wisconsin, and Minnesota
Total land area 18,860 sq.mi (48,847 sq.km), natural basis

(Area as defined in The National Resources Inventory and this study; descriptions from *Major Land Resource Regions and Areas of the United States*. (U.S. Department of Agriculture, Soil Conservation Service. 1981, Agriculture Handbook 296, p.77.); also see pp.151,156 and accompanying aerial photographs for southwestern Wisconsin and southeastern Minnesota in the USDA monograph *Land Use and Its Patterns in the United States(*Marschner, 1959).

Land Use

Nearly all this area is in farms, but only about two-fifths in cropland. Feed grains and forage for dairy cattle and other livestock are the principal crops. About one-fifth of the area is permanent pasture. Nearly one-third, mainly the more sloping parts, consists of farm woodlots used for commercial timber production and for farm products. The Mississippi River and major tributaries provide opportunities for recreation. Controlling erosion on sloping lands and protecting lowlands from stream overflow are the principal concerns of management.

Elevation and Topography

Elevation ranges from 200m (655ft) on the valley floors to 400m (1,300ft) on the highest ridges. The sloping to hilly uplands are dissected by both large and small tributaries of the Mississippi River. Bottom land along all streams is narrow. Some ridge tops are broad and have undulating slopes. Local relief is mainly several meters to several tens of meters.

Climate

Average annual precipitation is from 750 to 900mm (30-35in). Two-thirds or more of the precipitation falls during the freeze-free period. Average annual temperature is 7 to 10°C (45-50°F). Average freeze-free period is 140 to 160 days.

Water

In most years the moderate precipitation is adequate for crops and forage, but in years of little or no precipitation, yields on thin soils over bedrock are reduced. Ground water is abundant in outwash deposits in the valleys, but the amount varies on the uplands. The supply of ground water in areas underlain by sandstone and limestone generally is moderate. The many springs, streams, and farm ponds are additional sources of water.

Soils

Most of the soils are Udalfs. They are moderately deep and medium textured. These soils have a mesic temperature regime, an udic moisture regime, and mixed mineralogy. Well drained Hapludalfs (Fayette, Dubuque, Seaton, Gale, Nordness, and Norden series) that formed in a loess mantle over bedrock or in glacial till are dominant. Nearly level to gently sloping Argiudolls (Tama,

Dodgeville, Richwood, and Dakota series) and Hapludolls (Muscatine series) are on benches and broad ridgetops. Hapludolls (Frontenac, Brodale and Bellechester series) are on steep slopes bordering the major valleys. Well drained Udifluvents (Dorchester, Chasenburg, and Arenzville series) are along streams bottoms. Quartzipsamments (Boone series) are on steep slopes, and nearly level Udipsamments (Plainfield and Gotham series) are on stream benches. Steep, stony, and rocky soils are also common in the area.

Appendix C
Sample County Agricultural Histories

These brief accounts condense information from Censuses of Agriculture, soil and erosion surveys, and other documents generally dated for the period 1925-1935; but also from some more recent Censuses of Agriculture and of Population as sources of current income data. Some observations are from soil surveys for other counties in MLRA 105, including nearby Dubuque and Clinton Counties in Iowa and Trempealeau County in Wisconsin. The principal soil or erosion surveys reviewed include those of Benton and Gray (1925), Brown and Nygard (1936), Edwards with others (1928,1930), Gray and others (1929), Perfect and Sheetz (1942), and the Coon Valley Project Monograph of the Soil Conservation Service (1939).

Clayton County, Iowa

Pioneer settlement of the Clayton County area began in 1833; the county as such was organized in 1837. The population increased steadily until 1870, and then less rapidly until 1900, when it reached a peak of 27,750. Early farm products, chiefly grain, were shipped by steamboats on the Mississippi River to markets farther south or hauled inland by oxen. In 1930 the population was predominantly rural, when there were 2,990 farms. The total population of Clayton County in 1992 was 18,735, only one-fourth of whom lived on 1,620 farms. In 1992 about 23 percent of the personal income of the employed labor force was derived from farming or forest-related enterprises.

Many of the early settlers located their farms on the timbered lands that were easily cleared and cultivated, as the equipment needed to break the tough prairie sod was not available. However, the prairie soils were soon recognized as superior to the timbered soils and large areas were broken and farmed.

Early farming largely depended on growing wheat as the major crop. When corn varieties were found that would do well in local climates, the acreage of corn increased rapidly. The area in wheat decreased sharply after 1880 and corn became the major crop. Oats then replaced wheat as a major crop. Another factor in this change was the transition to a more market-oriented agriculture from small subsistence farming, even with animal power remaining important.

In the years between 1925 and 1935, the type of agriculture in Clayton County consisted of general farming, including the raising and feeding of hogs, cattle, and sheep; considerable dairying; and the growing of corn, small grains, and hay crops. Clover and timothy were the chief hay crops, and nearly all hay was consumed on the farms where grown. Hog raising was the most important livestock industry, followed by dairying.

The Censuses of Agriculture for 1925, 1930, 1935, and 1992 collectively provide a good picture of the kind of agriculture prevailing in the base year 1930, compared with 1992. In 1930 nearly 40 percent of the harvested cropland land was in row crops, with 86.4 thousand acres of corn accounting for 95 percent of all row crops and for over 35 percent of all crops harvested, including hay. Vegetables and Irish potatoes were other important row crops. They were grown primarily for home consumption.

By 1992 nearly 190 thousand acres were in row crops like corn and soybeans, This was almost double the 1930 acreage in corn, and accounted for over 70 percent of the cropland harvested, compared with the 40 percent in 1930. The relatively few soybeans grown in 1930 were essentially used as forage.

Oats were the leading close-grown or small grain in 1930 (64.6 thousand acres), followed by barley (9.2 thousand acres). By 1992 the area in oats had fallen to 14.5 thousand acres, but oats were still the leading small grain grown in the county. There were only 1,300 acres of wheat in 1930 as wheat had already become a minor crop compared with its early years in the area. In 1992 only 175 acres of wheat were reported for the entire county. More on the decline of wheat growing is in the histories for other counties in the region.

Along with the large increase in corn acreage since 1930, yields have increased dramatically owing to the development of improved hybrid varieties and better control of insect and disease problems. Corn yields averaged only about 40 bu/ac from 1930-35 as indicated in early Iowa crop reports (table A-5). The 1987-92 average computed from the Census of Agriculture was over 130 bu/ac. Oat yields also averaged 40/bu/ac from 1930-35, but now run about 65 bu/ac.

Crop yields in themselves influence soil erosion, because they determine the amount of protective crop residues that can be left on the surface or turned under to replenish soil organic matter. Also, a relatively dense protective canopy during the growing season not only indicates good yield prospects but also reduces the erosive impact of intense rains.

The area in hay crops and the frequency of meadow in crop rotations have a major influence on average annual soil erosion losses. In Clayton County in 1930 roughly 53.4 thousand acres or 25 percent of the cultivatable cropland was in rotation meadow, averaging about one acre for each 3 acres in row crops or small grains. Another 17 thousand acres were in other hay-type crops, giving a total for hay of 70,000 acres. In 1992 there were also about 70 thousand acres of hay cut, of which 55 thousand acres or close to 80 percent was alfalfa meadow in various rotations. While alfalfa currently appears to be the hay of choice, the leading hays in 1930 were various clovers and timothy. Alfalfa in rotation or otherwise accounted for less than 3 percent of all hay harvested. In 1930 rotation meadow in the general area consisted mostly of clover or clover/timothy mixes, legume and grass seed crops, and some annual legumes like soybeans and cowpeas harvested for feed.

Houston County, Minnesota

This area was first settled in 1848. Before 1854 Houston County was part of Fillmore County, and was named for General Sam Houston. In a few years as in other surrounding areas the early settlers became almost entirely wheat farmers, owing to the gradual westward movement of wheat farming. The Civil War greatly stimulated wheat production. After that War large areas of land farther west were opened for wheat and prices fell. This, combined with decreased yields from

insects and diseases, caused wheat to become a minor crop in Houston and other counties in the Northern Mississippi region.

In 1930 there were 1,910 farms in Houston County. The total population was 13,345; it was nearly all rural as no town had more than 2,500 people. In 1992 the total population was 18,790 persons; only about 2,800 or 15 percent lived on 975 farms. Farm employment accounted for 13.5 percent of all personal income earned in the county.

In the 1930's the usual Corn Belt crops of corn, oats, barley and clover and timothy hay were grown. Virtually all the crops and hay were fed on the farms to dairy cattle and hogs. Some tobacco, flaxseed and fruits were sold for cash.

As in Clayton County about 25 percent of the cultivatable cropland was in rotation meadow in 1930, but there were another 43.5 thousand acres in non-rotation hayland, giving 65.4 thousand acres in grass or legume crops, or about 45 percent of all cropland harvested. Only 3.6 thousand acres were in alfalfa meadow in 1930, contrasted with 39 thousand acres in 1992.

The grain crops in 1930 were about equally divided between corn at 35.2 thousand acres and small grains at 35.8 thousand acres, mostly oats and barley. By 1992 there were 65.2 thousand acres in corn or soybeans alone. Oats and other small grains totaled only 8.5 thousand acres. Corn yields in 1987-92 averaged 125 bu/ac, compared with the 40 bu/ac average yield recorded by the Minnesota Crop Reporting Service for the years 1930-35 (table A-5).

Winona County, Minnesota

The first substantial settlement of Winona County began soon after 1851, when a large part of southern Minnesota was ceded to the United States by Indians. Winona County was formed in 1854 from part of Fillmore County. By 1868 the city of Winona was rated as the fourth largest shipping center in the United States, specializing in wheat and lumber shipment to southern and eastern markets.

When farming began, general farm crops and vegetables were grown, but they were quickly surpassed by wheat. Wheat production then reached its maximum around 1877. Thereafter it declined and was displaced by malting barley and oats. Settlement in the county peaked about 1880, when there were 2,394 farms and 65.5 percent of the farmland had been improved. In 1930 there were 2,060 farms and the county's rural population was 10,409, down from its 1880 peak of 15,593. Including major towns like Winona, the county's total population in 1930 was around 35,000 people. In 1992 the county had 47,769 residents, of whom only 3,800 lived on 1,090 farms. Those engaged in farming in 1992 earned about 7 percent of the personal income of county residents.

The Cooperative Creamery Movement, started around 1897, stimulated dairying in Winona County as other counties in the region. Dairying became the major farm enterprise, with most other farm operations supporting or built around it.

The cropping patterns for Winona and Houston Counties, Minnesota in 1930 were somewhat dissimilar. Both had around 36 thousand acres in corn, but Winona County had over twice as much land in small grains, with oats at 35.4 thousand and barley at 26.3 thousand acres. Row crops, the small grains or rotation meadow accounted for 80 percent of all cropland harvested, with rotation meadow accounting for 23 percent of the cultivatable cropland. Rotation meadow and other grass/legume hays represented nearly 35 percent of all harvested cropland in Winona County, about the same percentage as in Clayton County, Iowa, but lower than the 47 percent for Houston County.

Average corn yields in Winona County for the years 1930-35 were 35 bu/ac; oats averaged 35 bu/ac. These yields were slightly below those for other sample counties (Table A-5). Corn yields for the two most recent Census years 1987 and 1992 averaged 120 bu/ac. The average oat yield was 60 bu/ac.

Crawford County, Wisconsin

The first settlement in Crawford County dates back to 1781, near what is now the city of Prairie du Chein. In 1930 the population of Crawford County was about 16,800 and there were 1,915 farms. The 1992 population was virtually at the same level--at 16,014, but only 16 percent lived on farms. By 1992 the number of farms had fallen to 975. Farmers earned 17 percent of the personal income received in the county in 1992.

In the first few decades following settlement, agriculture was confined mostly to the production of subsistence crops for the household and wheat for market. Livestock were raised for home consumption but as transportation facilities improved livestock became an important source of farm income. By 1900 they had become more dominant than grain production. With livestock increases, especially in dairying, more attention was given to forage crops, especially red clover and alfalfa.

In Crawford County tobacco became a well established cash crop. It had shown a continuous increase between 1880 and 1930. There were 2,400 acres in tobacco in 1930, but farmers reported only 540 acres in the 1992 Census of Agriculture.

Rotation meadow in 1930 occupied about 25 percent of the cultivatable cropland in Crawford County. It and other hay crops accounted for nearly 50 percent of all harvested crops. In 1992 rotation meadow totaled 41 thousand acres, nearly all of which was alfalfa. This was slightly more than the combined area in corn, soybeans, and the small grains.

Owing to some extensive areas of fertile valley soils, crop yields in Crawford County in the 1930-35 period appeared to range somewhat higher than in some neighboring sample counties. The 1930 Crawford County Soil Survey cited expected corn yields on the Bertrand and Ray silt loams ranging up to 70 bu/ac; the overall county average for corn was 50 bu/ac (table A-5). Oats, normally grown more often on the less productive soils, averaged 40 bu/ac. Based on the same Soil Survey and the 1930 Census, tobacco yields ran about 1,400 lbs/ac. Yields averaged for the Census years 1987 and 1992 were 110 bu/ac for corn, 55 bu/ac for oats and about 1,525 lbs/ac for tobacco.

Vernon County, Wisconsin

Permanent settlement of Vernon County dates back to 1844. Before 1851 Vernon County was part of Crawford County, Wisconsin. In 1855 the County's population was 4,800 and in 1930 was about 28,500, when there were 4,015 farms. The county's population in 1992 was 26,007, with around 6,000 living on 2,060 farms and earning 22 percent of the personal income.

In the early years wheat was the main cash crop, and sheep raising soon developed beyond meeting local needs. Also, tobacco became an important cash crop. It increased steadily up to about 1920 and then stabilized. At first beef production was the leading livestock enterprise but by 1910 was surpassed by dairying.

In 1930 the agriculture of Vernon County was dominated by dairying, supplemented by hog and sheep production and to a lesser extent by cash crops like corn and tobacco. The same is true today, except that sheep and wool production have decreased sharply.

Nearly 9,000 acres were in tobacco in 1930; this had declined to about 2,500 acres by 1992. About 31 thousand acres were in corn in 1930; this had increased to 53 thousand acres by 1992. As in neighboring counties, the area in small grains has decreased significantly, falling in Vernon County from 47.8 thousand acres in 1930 down to about 7 thousand acres in 1992, and the small grains remaining were nearly all in oats. Corn yields around the year 1930 apparently averaged 45 bu/ac according to the 1928 Soil Survey for Vernon County (table A-5). Yields now average 115 bu/ac according to the 1987 and 1992 Censuses of Agriculture. The average yield for oats in 1930 was 40 bu/ac; this had increased to an average of 55 bu/ac for the years 1987 and 1992. In 1992 tobacco yields were about 1,600 lbs/ac, compared with 1,200 lbs/ac in 1930.

In 1930 about 20 percent (23.6 thousand acres) of the cultivatable cropland in Vernon County was in rotation meadow crops, but another 77.3 thousand acres were in nonrotation hay. These crops accounted for over 50 percent of all cropland harvested. Significantly, by 1992 the area in tame hay, nearly all of which was alfalfa, had increased to 72 thousand acres. This was more than the combined area in corn, soybeans, and the small grains.

Appendix D
Other Major Land Resource Areas for Study

Area 1: MLRA's in Washington State

07 Columbia Basin
08 Columbia Plateau
09 Palouse and Nez Perce Prairies

Severe wind erosion in this area was noted in the Reconnaissance Erosion Survey (RES). The area has extensive highly erodible land and an important source of sediment. Much of the highly erodible land is in wheat. Enrollment in the Conservation Reserve Program (CRP) is substantial.

Area 2: MLRA's in Montana, North Dakota, South Dakota

52 Brown Glaciated Plain
53A, 53B, 53C Dark Brown Glaciated Plains
54 Rolling Soft Shale Plains
55 Black Glaciated Plains

Widespread wind erosion was noted in the Reconnaissance Erosion Survey of 1934. Wind erosion was severe in pockets throughout North Dakota, with a few areas of sheet/gully erosion. There is a high concentration of highly erodible cropland in northern Montana, the so-called winter wheat Triangle. The area is not too important as a source of sediment, probably because of wind rather than sheet erosion being dominant. In 1992 there was a high concentration of land in the

Conservation Reserve Program (CRP), which is concerned primarily with removing highly erodible land from production. Irrigation is also important and widely scattered.

Note: North Dakota is almost entirely within MLRA's 53, 54 and 55. Using the entire State as a study area would take advantage of State-level data on conservation practices and investments being developed in other RCA studies, including data on watershed programs.

Area 3: MLRA's in Nebraska, Kansas, Oklahoma, Texas and New Mexico, Colorado

71 Central Nebraska Sand Hills
72 Central High Tableland
73 Rolling Plains and Breaks
74 Central Kansas Sandstone Hills
77 Southern High Plains

These areas are characterized by various kinds and degrees of erosion, both water and wind erosion. The areas contain some very concentrations of erodible land, especially in southwest Kansas, west-central Nebraska, the Oklahoma Panhandle and north Texas. A considerable acreage was enrolled in the CRP in 1992. The areas all have a diversified crop and animal agriculture; wheat, corn, sorghum, cotton are all major crops. Irrigation is widespread, from both surface water projects and ground water systems.

Area 4: MLRA in Wisconsin, Minnesota, Iowa and Illinois

105 The Northern Mississippi Valley Loess Hills
(This is the area with which this trial study was concerned)

Area 5: MLRA's in Ohio, Pennsylvania, West Virginia

124 Western Allegheny Plateau
126 Central Allegheny Plateau

Moderate sheet and gully erosion according to the 1934 Reconnaissance Survey. The areas have considerable highly erodible land and are a moderate source of sediment. Corn is the dominant row crop, and is grown on fairly small fields compared to other regions. Livestock are also important.

Area 6: MLRA's in Tennessee, Mississippi, Kentucky

134 Southern Mississippi Valley Silty Uplands

Sheet and gully erosion were moderate in this area according to the Reconnaissance Erosion Survey. Lower reaches of the MLRA appear highly erodible and important contributors of sediment. There is some but not major participation in the CRP. Cotton and soybeans are the major crops, followed by sorghum.

Area 7: MLRA in Alabama, Mississippi, and Arkansas

135 Alabama, Mississippi and Arkansas Blackland Prairie

Sheet and gully erosion were severe in this area according to the Reconnaissance Erosion Survey and other studies. The area has a considerable acreage of highly erodible land and is also an important source of sediment. Cotton and soybeans are the major crops.

This area is also said by Trimble to warrant special interest because of devastating past erosion (1985,p.77).